THURSDAY, OCTOBER 17, 1912.

NATURE IN ROMAN LITERATURE.

The Love of Nature among the Romans during the Later Decades of the Republic and the First Century of the Empire. By Sir A. Geikie, K.C.B., F.R.S. Pp. xi + 394. (London: John Murray, 1912.) Price 9*s.* net.

THIS is indeed a delightful book, full of contagious zest and charm. The love of nature, the love of science, the love of the best literature both of the past and the present, all combine to make it so. It represents the happy adventure of one of our very foremost men of science, the President of the Royal Society, and the *doyen* of British geology, into the realm of classical scholarship and Roman literature. The "classics," as they are commonly called among those who love them and write about them, suffer too often by being made a business of. The affection of the schoolmaster or the classical professor is discounted as being professional, and its sincerity is a little doubted. It is only when some old statesman or soldier, some lawyer or physician, some original modern poet who has made his own name, after experience of the world, turns again, as Cardinal Newman in the famous passage in the Grammar of Assent describes him doing, to the Homer or Horace of his schoolboy hours, that we feel that the classics are being taken at their real value and that their natural undying charm is once more powerfully vindicated.

Specially is this the case when their beauty is avowed, *quod minime reris,* by a man of science. But, indeed, there should be no feud between the love of natural knowledge and of literary art, and, above all, of poetry, the best of which rests so much upon the close observation and faithful presentment of nature. There used not to be such a feud. It may be hoped that we are returning to a more healthy condition both of science and of scholarship when a book such as this comes into being. What were its occasion and origin Sir Archibald Geikie tells us in his modest, pleasant preface. He was asked by the Classical Association to become their president, and he chose, he tells us, for his address a subject which "seemed in some measure to combine the classical interests of the members with his own deep love of nature." This book is the expansion of the address which he then gave—an address which came, perhaps, as somewhat of a surprise to some, but not to those who knew Sir Archibald well or who remembered his Romanes Lecture at Oxford, or his book on "Landscape in History."

Such readers will not be surprised to hear that this new volume is excellently written. The great masters of science have usually written well, but this is more than well written. It is eminently readable, in a style at once lucid and sustained, and sympathetic with its subject. Indeed, it might be used to point the moral that an acquaintance with the masterpieces of antiquity is not without its uses to the modern student or exponent of science.

What may surprise, is that the President of the Royal Society should prove himself so well informed a scholar and, to use the classical phrase, so "ripe" a scholar. For not only is he well "posted up," not only has he read his monographs, his Pelham on the Italian *pascua,* or his Boissier's "Varron"—a rare book—but, still more, to the accuracy and completeness which his science might teach him, he adds a judgment, tact, and taste, pre-eminently considered, mellow, and mature.

It may be noted that he has for the most part translated himself, and often into verse, the many quotations which he makes from the Latin poets. This is a bold course, but justified both by the general good level of the renderings, and still more because it secures two advantages, the first, that of exactness of understanding for the writer himself; the second, that of consistency of presentment for his readers.

The volume, then, is essentially a "humane" book. It is written with real feeling and *con amore.* Geology, notwithstanding its "stony names," of which Tennyson made such ingenious poetic use,

> Of shale and hornblende, rag and trap and tuff,
> Amygdaloid and trachyte,

is really a humane study, for it deals with the structure of the dwelling in which we live, the history and character of the home of our race so far back as we can trace its chronicle.

When Sir Archibald looks at the literature, the poetry, the mode of life, the tastes of the Romans with the "modern eye," the scientific eye, he naturally first sees Italy as a geologist, and, so doing, throws a new light on the figures and epithets, the descriptions and the criticisms, with which the scholar is so familiar.

Italy, the Italy of Cicero and Virgil, the

> Magna parens frugum, Saturnia tellus
> Magna virum,

was always, in the broad geological and geographical sense, the Italy she is now; her kindly and temperate skies with their *indulgentia caeli*; her double sea, largely the secret of her skies; her northern wall and spinal chain of mountains; her lakes; her short rivers, here torrent,

here stagnant, now in "spate," now parched threads, the consequence of these mountains; her volcanic energies, slumbering or active—these have always been the same. They make the *mise-en-scène*; they give the colour and the form to the pictures which her poets have drawn in all ages. They are the eternal factors on which the tillers of her soil, the cultivators of her woodlands, have counted, and with which they have contended, from age to age.

The Romans and the ancient Italians were a race of "country men" and "country gentlemen." The rich and fashionable loved to go to "town" for the season. The poorer, when they could get so far, loved more and more the excitement of the city shows and spectacles too, but there were many among both who also loved the country, and not a few who, especially in middle and later life, loved the country more. Like Burke at Beaconsfield or Warren Hastings at Daylesford, like Gladstone at Hawarden or Disraeli at Hughenden, Cicero and Hortensius enjoyed, even if they kept one eye ever on Rome, the refreshment of their *villegiatura*. Horace, though for a time, like Browning, a lover of society, a dandy, and a diner-out, yet more and more came to prefer his Sabine farm. Virgil, like Tennyson, made rare and shy incursions into the metropolis, but like Tennyson again at Farringford or Aldworth, so Virgil at Naples or Nola preferred the *secessus*, the solitude of sea and upland.

Sir Archibald has brought out another resemblance between these two poets, for just as Tennyson never forgot the smallest detail of the "wold" and "marsh" and "table-shore" of Lincolnshire, so Virgil, as he points out, drew from memory, but with astonishing fidelity, the scenery of the northern home he had long left. It is true that in his early poems he introduces, by a sort of *mirage*, the scenery of Theocritus' Sicily, into the plains of Lombardy, but the greater part of his drawing is, as Sir Archibald Geikie points out, "from the life." For Virgil was by birth and nurture a countryman—indeed, a peasant. He was "brought up among orchards and woodlands." He knew the country, and he was a most accurate observer of nature. Sir Archibald Geikie quotes as an instance the famous passage in which he describes the wave rushing up, breaking in foam, flooding the sandy coves, then retreating, at first dragging the spinning pebbles with it, then finally thinning out, as it retires, into a sliding, shallow tide—"picturing," as he says, "in four pregnant words, one of the great dynamical processes of the sea." "Virgil," he adds, "knew nothing of the scientific meaning of the facts he noted, but no man of science could have observed them more accurately or described them with more concise precision." He dwells, too, on the appeal to another sense, the ear: the representation by an alliteration of rough "r's"—"*nunc rapidus retro atque aestu revoluta resorbens,*" of what Tennyson, as he recalls, describes as "the scream of the maddened beach dragged down by the wave."

Sir Archibald Geikie doubts whether Virgil had seen the Lake of Como. He thinks that he probably knew the Lake of Garda, from which his own Mincius takes its course. Another scientific poet and lover of nature had no doubt. No one who has read it will forget the passage in which Goethe describes how, at the beginning of his "Italian Journey," he came to the shores of Garda; how he found the south wind blowing up the lake, lashing it into loud and dangerous waves; and how, as he waited and listened to their murmur, he realised after eighteen centuries the fidelity of Virgil's line:—

Fluctibus et fremitu assurgens Benace marino.

The truth is, Virgil was a great "naturalist," and must always furnish the greater part of the material for any writer who tries to estimate the Roman appreciation of nature. That he does so for Sir Archibald Geikie, a glance at the index will show. One of the best passages in the volume is a page of eloquent, if condensed, prose summing up Virgil's love of woods and woodlands. But Virgil was something more than an observer. He was by education not a little of a philosopher also. It is here that he joins hands with Lucretius, whom Sir Archibald Geikie calls a philosopher and man of science, and of whom he says:—

"Among all the poets of ancient or modern times he stands out as the one who may perhaps most fittingly be called the poet of nature."

If Virgil sprang from a peasant stock, Lucretius was of a noble family. His vivid pictures of the *blasé* Roman noble ordering his smart team of "jennets" and tearing from Rome to his place in the country, and then as rapidly back again, is drawn from habits with which he was familiar. But he himself, as these pages remind us, loved the country, mountain, sea and shore, and was in particular specially fond of animals. He loved still more the scientific speculations which these sights, or the contemplation of sun and moon, or the "wide and starry sky," suggest to the thoughtful student. His science he derived, like all Romans, from Greece.

It is not part of Sir Archibald's scheme to include the "love and knowledge of nature among the Greeks," except in so far as this is implied

and contained in Roman thought and writing. That measure is, of course, a large one. The Alexandrines in particular, only partly Greek, and living and learning in cities and university towns, amid libraries and observatories, first developed the modern love alike of nature and of natural science. From them it passed to Rome. Aratus, the poet and fellow-countryman whom St. Paul quoted at Athens, was one of the most popular poets at Rome, and influenced, as the President of the Royal Society points out, Cicero and Virgil; he might have added, through Cicero, Lucretius also. Both Lucretius and Virgil, however, owed more still to the prevailing Epicureanism, which from the Greek schools of their time passed over to and permeated Italy. Catullus and Horace and Ovid fell under the same Greek influences.

But this is not the true, genuine native Roman love of nature. That love, a more superficial yet in some ways more natural and pleasing thing, is, as these pages show, to be found in almost all the poets from Catullus to Statius and Martial, in the prose-writers from Varro to Seneca. Its varied expressions and manifestations constitute a rich and copious subject, but Sir Archibald deals with this very skilfully by arranging it under different headings: the love of flowers; the love of animals; Roman gardens; flowers and foliage in Roman art; day and night; the seasons; springs, rivers, and lakes; mountains; the seashores; and so on. The result is that he is never tedious. The reader can take up any chapter and almost any page separately, and find something to interest him—the character of the melancholy, amorous Propertius, asking to be "put among the girls"; the clever, frivolous, querulous Ovid; the intense, direct Catullus; the pretentious and somewhat hypocritical Seneca; the importance and the character, almost personal in its significance, of winds and stars to the ancient farmer and seaman; the testimony of the Pompeiian wall-frescoes, half foreign, half local and native, their figures Greek, their landscapes Latin—each is touched in succession with a fresh eye and firm hand.

Incidentally, also, as might be expected, there are references to modern writers—not only to Tennyson, already alluded to, but to Spenser and Shakespeare, to Cowley and Cowper, to Coleridge and Keats, and, of course, to Wordsworth. Perhaps one of the most striking points which is made in these pages, is that the ancients too possessed that

"inner eye
Which is the bliss of solitude."

Indeed, the Romans had the very expression, for does not Ovid in his "Metamorphoses," as Sir Archibald Geikie points out, write:—

Quae natura negabat
Visibus humanis, oculis ea pectoris hausit?

To conclude, the theme is one which has been touched before, notably by Prof. W. R. Hardie in "Lectures on Classical Subjects," published about a dozen years ago, but never has it been handled so thoroughly or with more freshness and suggestiveness than by the President of the Royal Society in this volume, which we confidently commend to scholars and men of science, but still more confidently to the general reader.

T. HERBERT WARREN.

PHYSICS—POPULAR AND APPLIED.

(1) *Matter and Energy.* By F. Soddy, F.R.S. Pp. 256. (London: Williams and Norgate; New York: Henry Holt and Co., n.d.) Price 1*s.* net. (Home University Library of Modern Knowledge.)

(2) *Practical Exercises in Physiological Optics.* By Dr. G. J. Burch, F.R.S. Pp. 164. (Oxford: Clarendon Press, 1912.) Price 4*s.* net.

(3) *The Energy System of Matter.* A Deduction from Terrestrial Energy Phenomena. By James Weir. Pp. ix+200. (London: Longmans, Green and Co., 1912.) Price 6*s.* net.

(4) *The Cinematograph and Natural Science.* The Achievements and Possibilities of Cinematography as an Aid to Scientific Research. By L. Donaldson. Pp. 88. (London: Ganes, Ltd., 85, Shaftesbury Avenue, W., 1912.) Price 2*s.* 6*d.* net.

(5) *Oscillations et Vibrations.* Étude générale des Mouvements Vibratoires. By A. Boutaric. Pp. ix+403. (Paris: Octave Doin et Fils, 1912.) Price 5 francs. (Encyclopédie Scientifique.)

(6) *Physik.* Zum Gebrauch bei physikalischen Vorlesungen in höheren Lehranstalten sowie zum Selbstunterricht. By Prof. H. Böttger. Erster Band: "Mechanik, Wärmelehre, Akustik." Pp. xiii+983. ("Das Buch der Natur," Dreiundzwanzigste Auflage. Dritter Teil, Zweite Abt.) (Braunschweig: F. Vieweg und Sohn, 1912.) Price 15 marks.

(1) IT is always difficult for the reviewer of a book who naturally possesses a more or less intimate knowledge of the subject under review to write with confidence concerning a popular treatise. There is always the possibility that his previous knowledge enables him to appreciate many points which may not be so easily grasped by others less acquainted with the sub-

ject. And, after all, it is for this latter class that such books are primarily intended. But in the present case there is scarcely room for doubt that Prof. Soddy has successfully accomplished the very difficult task of making physics of absorbing interest on popular lines. This has been done without any of that sacrifice of exactness of statement which so often mars works of this kind; thus the trained physicist and the novice may read the book with equal pleasure. It is quite surprising how many phenomena the author has been able to deal with in this fashion, and what up-to date work he has been able to introduce. There is no space available to detail the various contents more than to say that such subjects as the kinetic theory of matter (including reference to Perrin's beautiful experiments on Brownian movements) and radioactivity, among others, are treated with admirable lucidity. A book of this kind deserves a longer review; it is to be hoped it will have a large circulation, for it forms a worthy addition to the excellent series to which it belongs.

(2) This consists of a series of descriptions of experiments which Prof. Burch has compiled, based upon the work of practical classes in the Physiological Laboratory, Oxford. About sixty experiments are described, dealing with the dioptrics of the eye, judgments of the eye, sensations of the eye, the measurement of colour sensations, and experiments with flashing light.

(3) From time to time during the progress of physical science a book appears the author of which is thoroughly dissatisfied with everything that has been accomplished, and desires to begin again on an entirely new foundation. This book is the latest of the kind. The author, in this case, claims to have made an intimate study of natural phenomena, and to possess a lengthened experience in physical research. Such a claim is, however, scarcely borne out by a perusal of his book. One cannot help thinking that his dissatisfaction with things in general arises rather from his own lack of acquaintance with the exact nature of physical science than from any fundamental error in present-day theories. It is really impossible to take the book seriously; at any rate, the present writer finds it so.

(4) This is a little book dealing with various applications of the kinematograph to scientific research. The author directs attention to what has already been achieved, and throws out suggestions as to the lines upon which further progress could be made.

(5) This is a treatise of a rather advanced character, though very much compressed, upon wave-motion, &c., particularly in its applications to sound and light. It is rather poorly printed, and the diagrams are not well produced.

(6) Like many similar German text-books of physics, the treatment in this one is very full—surprisingly so when it is remembered that it is intended for use in schools. This is the first volume, and comprises mechanics, heat, and sound. The type and diagrams are good.

MICRO-ORGANISMS AND THE HOMESTEAD.

(1) *Microbiology for Agricultural and Domestic Science Students.* Edited by Prof. C. E. Marshall. Pp. xxi+724. (London: J. and A. Churchill, 1912.) Price 10*s.* 6*d.* net.

(2) *Microbes and Toxins.* By Dr. E. Burnet. With a preface by Elie Metchnikoff. Translated from the French by Dr. C. Broquet and Dr. W. M. Scott. Pp. xvi+316. (London: William Heinemann, 1912.) Price 5*s.* net.

(3) *Bacteria as Friends and Foes of the Dairy Farmer.* By Wilfrid Sadler. Pp. xv+112. (London: Methuen and Co., Ltd., 1912.) Price 1*s.* 6*d.*

(1) MICRO-ORGANISMS are of far-reaching importance in agriculture, and the domestic science student cannot afford to neglect them, and the appearance of a work dealing with these branches of bacteriology, particularly the latter, is therefore opportune.

A number of well-known authors, specialists for the most part in their various subjects, have collaborated to produce the book under review. The editor, Prof. Marshall, fully recognises the weakness of this system of compilation, and has attempted, with success we think, to coordinate the whole. He points out that the term "bacteriology" has come to include many groups of micro-organisms other than the true bacteria, and the term "microbiology" has therefore been employed as a title for the present book.

The scheme of the book is comprehensive and well conceived, and ranges over a wide field. The subject-matter is divided into three parts: the first deals with the morphology and culture of micro-organisms, including the Protozoa; the second with the physiology of micro-organisms; and the third with applied microbiology. The last includes sections on air, water and sewage, the soil, milk and milk products, the preservation of foods, alcohol, vinegar and other fermentation products, and the microbial diseases of plants, man, and animals. We have found practically nothing in the contents to criticise, and the book is well illustrated with 128 figures in the text and one coloured plate of the malaria parasite.

(2) This book fills a lacuna in bacteriological

literature, inasmuch as it deals with the general physiology and functions of micro-organisms. While appealing more particularly to the specialist, the general reader who has some biological training and desires to obtain a general survey of the activities of micro-organisms may peruse it with advantage. The third chapter, which deals with the form and structure of microbes, contains a brief but sufficient account of recent work on these subjects, and the section on reproduction and sexual reproduction of these lowly organisms is particularly good. The chapters on infection, immunity, and supersensitivation are models of judicious selection from the voluminous literature, and give excellent summaries of the subjects.

The author, being a member of the staff of the Pasteur Institute, naturally gives considerable prominence to the views of the French school on the physico-chemical nature of the toxin-antitoxin reaction, but the other hypotheses are fully and fairly stated. Final chapters deal with the applications of bacteriology, vaccines, and curative sera and chemio-therapy. We demur to the statement (twice repeated) that because an animal's serum may naturally possess some anti-toxic power towards diphtheria or tetanus toxin, such an animal *must* therefore have harboured the diphtheria or tetanus bacillus. Though this may be the explanation in some cases, we do not think that it is necessary to postulate such an infection in all instances. If antitoxin be generated during artificial immunisation by the detachment of *natural* side-chains from cell-protoplasm, there is apparently no reason why similar side-chains should not *normally* become detached by ordinary physiological processes, constituting the small amount of antitoxin sometimes found in a non-immunised animal.

We have read this book with much interest, and can recommend it as giving an excellent account of the subjects of which it treats.

(3) As Mr. Golding says in the introduction to this little book, "it has become an absolute necessity that the dairy farmer should be acquainted with some knowledge of the world of microscopic beings with which he is beset on all sides, and be able to distinguish his friends from his foes among this host which he cannot see, but to which he owes, and from which he fears, so much." We think that this book will well supply this kind of knowledge to the producer, the purveyor, and the consumer of milk. After a simple introductory statement of what bacteria are and how they grow and multiply, the use of starters for butter- and cheese-making is considered. The production of a pure milk is then discussed, and the sources and nature of contamination are described, the cow and milking, transit, distribution, and consumption of milk all being considered. A few pages are devoted to disease germs and the sour-milk treatment, and the book concludes with a short bibliography for the use of those who desire further information on the subject.

R. T. HEWLETT.

OUR BOOKSHELF.

Nature Photography. What to Photograph, Where to Search for Objects, How to Photograph Them. By Stanley C. Johnson, M.A. Pp. 115. (London: Hazell, Watson and Viney, Ltd., 1912.) Price 1*s.* net.

"NATURE" is a very wide term. It is not possible to state concisely the meaning that the author attaches to it. He does not refer to the larger animals, and though he gets down to beetles and butterflies, he does not include the smaller creatures that are generally called microscopic. He deals with fishes, birds, flowers, trees, reptiles and some of the larger insects, giving what is evidently his own experience in connection with the photography of such things. This personal character of the book gives it a value that a more inclusive compilation might not possess. He has very little to say about the actual photography, but treats rather of the selection and arrangement of the subjects, where and when to look for them, and so on, and in this connection gives advice that will be found of great value by those who do work of this kind.

In dealing with the bright colours and delicate shades that some of these objects present, the author's practice of using only stained plates ("non-filter," as they are called) cannot be regarded as thoroughly sound. His own illustrations of coloured objects are not good, but it is possible that the chief fault here lies with the maker of the blocks. The truthful rendering of various colours in monochrome is now fairly well understood by those who care to study the matter, and is not to be dismissed in a line or two by the simple recommendation to use any particular plate.

Dactylography, or the Study of Finger-prints. By Henry Faulds. Pp. 127. (Halifax: Milner and Company, n.d.) Price 1*s.* net.

THIS little book is the latest addition to the "Twentieth Century Science Series," which includes volumes that treat scientific subjects in a popular manner for the general reader. Mr. Faulds here writes in an interesting way on a subject with which his name has long been associated as an authority, and the reader is provided with a trustworthy account of the technique of printing and scrutinising finger-patterns and of classifying them. The practical results which followed the study of finger-prints are enumerated, and the future prospects of the subject outlined.

The Transactions of the American Institute of Chemical Engineers. Vol. iv., 1911. Pp. iv+514. (New York: D. Van Nostrand and Co.; London: E. and F. N. Spon, Ltd., 1912.) Price 30*s.* net.

Two addresses delivered by the president, Dr. F. W. Frerichs, at Chicago and Washington are chiefly devoted to descriptions of six problems in chemical engineering practice. One of these, the extraction of bismuth from carbonaceous ores, consists of a complete account of the recovery of this metal from ores containing 1 oz. of lead, 15 oz. of silver 5 per cent. lead, and 5 per cent. of bismuth. The metal can be produced greatly in excess of the consumption, which in 1910 was about 200,000 lb for the United States. It is used almost exclusively for medicinal purposes.

Mr. Clarence Hall, explosives engineer, United States Bureau of Mines, contributes an interesting paper on explosives used in engineering and mining operations. The apparatus used at the Pittsburg testing station for the determination of the relative energy and efficiency of various explosives, such as black powder, granulated nitroglycerine powders, and nitro-glycerine and ammonia dynamites, is described. Mettegang's recorder for determining the rate of detonation is used, and velocities of detonation up to 6246 metres per second have been found for 60 per cent. nitroglycerine dynamites. The recorder has a soot-covered bronze drum 500 mm. in circumference which can be driven up to 105 revolutions per second, and marks are made thereon by electrical contact devices.

The manufacture of gelatine is described by Mr. Ludwig A. Thiele. The raw materials are bones, from which osseine is derived, and hide-stock. The process is the same for the osseine and hidestock, the former being got from the bones by treatment with either hydrochloric, phosphoric, or sulphurous acid, during which process a valuable by-product, acid phosphate, is produced. A report of the Committee on Chemical Engineering Education is included in the volume, together with other papers on manufacturing processes.

Science French Course. By C. W. Paget Moffatt. Pp. x+305. (London: W. B. Clive, University Tutorial Press, Ltd., 1912.) Price 3*s.* 6*d.*

THE object of this book is, the author says, to provide students of science who desire to read French scientific literature with the necessary minimum of French grammar, and a selection of extracts from which some practice may be obtained. For students with no knowledge of French at all the amount of assistance given in translation appears rather inadequate, but for those who have forgotten what was learnt at school and wish to revise rapidly, the book should prove of great assistance. The extracts will form excellent reading in French for boys and girls in the upper forms of secondary schools who are taking a course of work in science.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Synthesis of Matter.

IN the issue of NATURE for July 18 last, there appears an important letter from Sir William Ramsay dealing with the appearance of hydrogen, helium, and neon in the glass of exhausted X-ray bulbs. This result is of great interest, and may have an important bearing in addition to that mentioned by the author.

It is well known that X-ray bulbs only possess a limited period of life and go "soft," as it is termed, as if a small amount of gas previously adsorbed by the glass had been set free. The thought occurred to me some time ago that the softening might not be due to this cause, but to rare gases, such as helium, actinium, &c., produced from the æther of the vacuum becoming charged with energy from the kathode. It is such gases which are found in the process known as inorganic evolution in the hottest stars and nebulæ, and discovered there first by Lockyer, before their terrestrial occurrence in cleveite and elsewhere was detected by Ramsay.

If elements can decompose with evolution of energy as in radio-activity, it would seem not impossible that matter might be synthetised with absorption of energy, and that a first stage in such a process might be the formation of electrons by the charging of æther with a permanent form of energy, followed by a synthesis of ordinary matter in which such gases as helium would be a first product.

Attempts were made by me at the time to obtain evidences of helium from exhausted X-ray bulbs, but failed, as I now believe, from the small quantity of gas available and my lack of training in this very specialised field of manipulation. It would be interesting to carry out a prolonged experiment with an X-ray bulb run for days, and pumped out at intervals, in order to ascertain whether such development of helium took place.

It is, of course, possible that any gas so arising might come from the electrodes and glass undergoing atomic disintegration, but the possible origin of matter from æther when there is an available supply of energy at high potential should not be lost sight of. Theory suggests that such a formation is possible, if matter consists of vortex rings or other permanent forms of periodic movement of the æther, and it may be that in the chromosphere spectra there is evidence of production of matter occurring at the present time.

BENJAMIN MOORE.

The Bio-Chemical Department, the University, Liverpool, October 9.

The Jaw from the Stalagmite in Kent's Cavern.

I AM much obliged to Prof. Keith for his reply to my letter on the Kent's Cavern jaw, from the granular stalagmite. As my friend Prof. Boyd Dawkins, who read the paper, was a member of the Kent's Cavern Committee, and reported in 1869 on the fossils found up to that date, I naturally took for granted that all the facts of the case would be before Section H, and that Prof. Keith was challenging the evidence.

On referring to Prof. Boyd Dawkins's 1869 report I noted with surprise that the jaw was not even mentioned. To those acquainted with the history of Kent's Cavern this omission is easily explained.

Throughout the explorations of the cavern, beginning in 1825, all the evidence in favour of the antiquity of man was challenged and explained away by outside critics. Objects in and under the stalagmite were accounted for in one of the following ways, viz.: (1) interments; (2) cracks or fissures; (3) the stalagmite was a comparatively recent invading magma!

For these reasons it would have been unwise, in 1869, to depend on any evidence so certain to be challenged. Indeed, the value of the evidence of the said jaw has not been publicly discussed up to the present time.

After Pengelly's death Sir John Evans published the second edition of his "Ancient Stone Implements," in which, alas! he seems to have followed the earliest explorers in the general assumption of fissures. Sir John observes that in the stalagmite there were few remains, "whether human or otherwise, and these for the most part may have fallen in from higher levels." He further observes that "concerning this long chapter in the history of human existence the records of the cavern are a blank." If I may venture to say so, the distinguished archæologist must have compiled his account of Kent's Cavern from early and late records as of equal authority.

So far as the weighty authority of the chairman of the Kent's Cavern Committee (but not on the committee when the jaw was discovered) is concerned, Prof. Keith would be fully justified in questioning the authenticity of the jaw in question.

In Pengelly's Glasgow lecture (1875) we find the words—"I have found teeth of the mammoth, teeth of the woolly rhinoceros, teeth of the cave hyæna, and teeth of the cave bear in the very uppermost part of the stalagmite; and a human jaw, with four teeth in it, at the base of the same deposit" (pp. 17–18).

In describing a bone pin found under the stalagmite, near the same spot as the jaw was found, Pengelly incidentally describes the stalagmite as "20 inches thick, perfectly intact, and *continuous in all directions*" (Report Brit. Assoc., 1867, p. 31). The italics are mine.

One item of evidence *per contra* must be noticed, viz. that "one of the artificially formed flints [from the stalagmite] has the appearance of being a fragment of a polished Celt or axe, and is the only specimen of the kind which has been found in the cavern." Nothing of the sort, we are told, was subsequently found.

It is much to be regretted that the British Association did not complete its sixteen years' exploration with a general summary of results, with plans and sections. There is, I believe, no general ground plan of the cavern in existence, except the rough sketch which I prepared for the last visit of the Geologists' Association (Proc. Geol. Assoc., vol. xvi., p. 437, 1900).

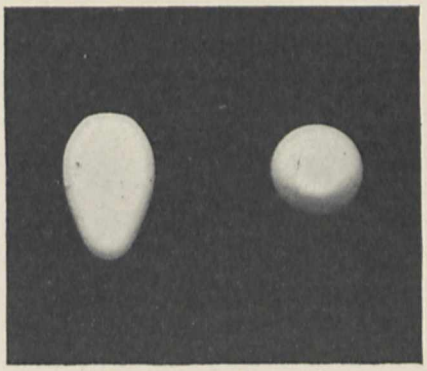
A. R. HUNT.

Torquay, October 7.

A Pearl from Nautilus.

THE accompanying photograph shows a pearl (natural size), alleged to have been found in *Nautilus pompilus*, from the Sulu archipelago. It was lent to me for examination by Mr. T. H. Haynes, of the Montebello Islands, north-west Australia, one of the pioneers of the pearl-shelling industry in Australia and the East Indies, who is now in England. This pearl was given to Mr. Haynes, about 1884, by a half-breed Chinaman named Oto, brother-in-law to the late Sultan of Sulu, Mohamed Budderuddin.

Mr. Haynes tells me that the pearly Nautilus is occasionally taken alive by the pearl-shell divers, by whom the flesh is considered a great delicacy. Now and then a pearl is found in a Nautilus, but as these pearls are considered unlucky they are usually thrown away. There is a superstition among the natives that, if a man fights with a Nautilus pearl in a ring on his finger, he will be killed. It is probable, therefore, that few, if any, examples of these Nautilus pearls have found their way into the West.



A Nautilus pearl. Natural size.

The pearl, which is a perfect pear-shape, slightly flattened at the broader end, weighs 18 carats (72 grains), and is composed of the porcellanous (not the nacreous) constituent of the shell. It is somewhat translucent, white, with a slightly creamy tinge, rather suggesting fine Beleek china. The broad end, which has apparently been flattened by pressure of the shell upon the pearl sac, is rather more transparent and vitreous.

H. LYSTER JAMESON.

Royal Colonial Institute, London, W.C.

Errors of the Computed Times of Solar Eclipse Phenomena.

WITH regard to Dr. Downing's letter on this matter (NATURE, October 10, 1912), may I be allowed to remark that I was fully aware of his warning that the computed eclipse times of second and third contacts were too late. In fact, I carried with me to Vavau the reprint of his paper to which he alludes (Monthly Notices R.A.S., vol. lxix., p. 31), which he had kindly sent me, and frequently consulted it. In addition, I had prepared an instrument for projection of the solar image so as to observe the angles of cusps given in his paper, but as Dr. Lockyer also had a similar instrument, we arranged that I should make use of his time signals.

As a further precaution, to obtain the time of the first flash, I had arranged a direct-vision spectroscope adjusted on the C line in the chromosphere at the angle of second contact. Unfortunately, the clouds at the time of second contact rendered all these precautions useless.

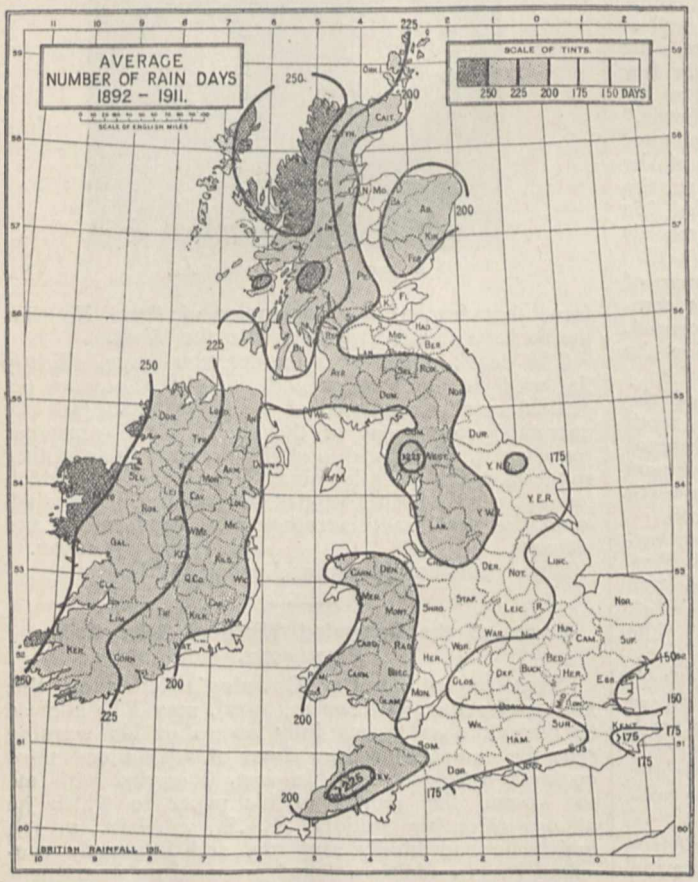
I trust that Dr. Downing does not read into my remark, "The total phase commenced about 20 seconds before the predicted time" (Proceedings R.S., No. A595), anything more than a mere statement of a fact.

A. L. CORTIE.

Stonyhurst College Observatory, October 14.

BRITISH RAINFALL IN 1911.

THE Director of the British Rainfall Organisation is to be congratulated on the volume he has produced [1] dealing with the rainfall of the British Isles, and for the compilation of which he has the assistance of 5300 observers. As time goes on the value of the work undertaken is greatly enhanced, not only by the extension of the observations and the greater accuracy of the results, but also by the completeness of the discussions rendered possible by the accumulation of data. The thoroughness with which the work is carried out both by the voluntary observers and by Dr. Mill and his assistants merits the greatest admiration, and is a masterpiece as a private undertaking.



A discussion of the distribution of rainfall in time is given which will prove of very great value, and is a matter of considerable interest even to the general public endowed merely with average scientific craving.

In a former volume for 1902, a first attempt was made in the same direction, dealing only with the observations for ten years, and these embracing chiefly a dry period. Now a period of twenty years, 1892 to 1911, is dealt with, and the results at 100 stations of established accuracy have been collated, which may with some confidence be expected to furnish a trustworthy average.

There is naturally a relation existing between the frequency and amount of rainfall, the wetter western districts showing a greater frequency than the relatively drier Eastern districts.

The rain days for the year on the average of twenty years range from 250 in the north-west of Scotland and the west of Ireland to 150 in the estuary of the Thames; and England, with the exception of the north-western and western districts, has fewer than 200 rain days in the year.

The map of frequency, like that of quantity, suggests very clearly the controlling influence of the westerly winds which predominate, and which are laden with moisture from off the Atlantic on their arrival over the British Isles.

The abnormal year of 1911 was believed to have been unparalleled for its dry periods, and under the heading of "Droughts in 1911" a comparison is made between the results for 1911 and the records of the last twenty-four years, selecting one hundred well-distributed stations in the British Isles; this shows that the surmise about 1911 is not without foundation. 1911 had more absolute droughts than any other year except 1887, and it had the largest number of partial droughts. An absolute drought is no rain for more than fourteen consecutive days, and a partial drought a period of more than twenty-eight consecutive days with a mean rainfall not exceeding 0·01 in. per day. The absolute droughts in 1911 were more than double the average, and partial droughts little short of three times the average.

Dealing with heavy rains in short periods, an exceedingly interesting table is given showing the rainfalls of very rare intensity lasting for one hour or less. The heaviest authenticated measurement is 0·33 in. in two minutes, which is equal to the hourly rate of 9·90 in. at Chepstow in March, 1888, and this is followed by 0·50 in. in four minutes, which is equivalent to 7·50 in. per hour, at Ilkley in June, 1906. A reported fall of 1·25 in. in five minutes at Preston in August, 1893, which gives a rate of 15 in. per hour, is accepted with caution. At Beddington, in May, 1903, a fall of 3·50 in. occurred in an hour. This table is of considerable value, as it affords means of comparison for such extraordinary rains as have recently occurred in Norfolk, where at Norwich, between noon and 1 p.m., September 26, the rainfall amounted to 1·15 in., and to 7·32 in. in twenty-four hours ending 4 a.m., September 27.

C. H.

[1] "British Rainfall, 1911." On the Distribution of Rain in Space and Time over the British Isles during the Year 1911, as recorded by more than 5000 Observers in Great Britain and Ireland, and discussed with Articles upon various branches of Rainfall Work. By Dr. H. R. Mill. The Fifty-first Annual Volume. Pp. 108+388. (London: Edward Stanford, Ltd., 1912.) Price 10s.

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

THE Congress of Applied Chemistry, which met this year in Washington and New York, is the eighth of a series of triennial gatherings held hitherto in centres of chemical activity in the Old World, the last three meetings having taken place in London, Rome and Berlin.

The onerous task of preparing for the reception of the eighth congress was commenced three years ago by an influential committee of American chemists, Prof. E. W. Morley and Dr. W. H. Nichols being nominated honorary president and president respectively, with Dr. Bernhard C. Hesse as secretary. The interesting programme drawn up by this committee attracted a large number of European chemists, chiefly from Germany, and about thirty nationalities were represented by official delegates. Among the eminent chemists attending the meeting were three past-presidents of former congresses—Prof. L. Lindet (Paris), Sir William Ramsay (London) and Prof. F. Strohmer (Vienna). Prof. P. Walden, president-elect of the next congress (St. Petersburg), was also present.

The scientific work of the congress was divided into twenty-four sections, and one very noteworthy feature, which distinguished this meeting from its predecessors, was the rapid printing of the proceedings in twenty-four volumes, containing nearly 600 accepted papers, these being ready for distribution to the members at the opening of the meeting on September 3. The discussions taking place in the various sections were recorded phonographically by a special phonograph devised for this purpose by Mr. Edison.

The congress was opened formally at Washington, in the Memorial Continental Hall, on September 4, and the delegates and members were welcomed by His Excellency President Taft, at the White House. Several Government institutions established at Washington were visited by the members, special attention being devoted to the laboratories of the Department of Agriculture, the Bureau of Standards, the Geophysical Laboratory and the U.S. Geological Survey. The scientific work of the sections was carried on in New York from September 6 till September 13, the meetings being held in the lecture-rooms placed at the disposal of the congress by the authorities of Columbia University, to whose generous hospitality the congress is indebted both for this suitable and compact group of rooms and also for the use of several residence-halls in which many members were housed during the congress meetings.

In the analytical section were presented several important papers and reports of committees on the standardisation of methods of sampling and analysis. The extraction of potash from felspars and other minerals was discussed in the section of inorganic chemistry, and joint meetings with the sections of metallurgy and mining were held to consider topics of interest in connection with new alloys, among which may be mentioned the combinations of boron with copper and other metals, demonstrated by E. Weintraub. The electric furnace and its applications was the subject of a joint session between the metallurgical and electrochemical sections. The production and properties of Portland cement were debated in the section of silicate industries. In the explosives section stability tests for these materials were discussed by several investigators, and tetranitroaniline was recommended by its discoverer, B. Flurscheim, as a safe explosive with a shattering power only second to that of nitroglycerin.

The section of organic chemistry received the greatest number of papers and was the scene of several animated discussions. The chemical structure of the azoimide nucleus present in organic and metallic azides was dealt with by M. O. Forster. The perennial topic of colour and constitution was discussed in joint session with the section of coal-tar colours, interesting papers on aniline black and quinonoid addition in dyestuff synthesis being contributed by A. G. Green. In the sugar section, reports were presented on uniform methods of sugar analysis by von Buchka, Prinsen-Geerlings, Saillard, Strohmer and Weichmann. A paper on the valuable plastic material "baekelite," the condensation product of phenol and formaldehyde, was read by its discoverer, L. H. Baekeland, before the section of indiarubber and other plastics. A report on the standardisation of methods of determining water in coal and in other fuels and in minerals, drawn up by G. T. Holloway, was presented by R. Lessing to the section on fuels.

Among the large number of important papers contributed to the section of agricultural chemistry may be mentioned a series of communications by G. Bertrand and his collaborators on the catalytic action in fertilisers of small quantities of manganese, boron, zinc and aluminium. The standardisation of disinfectants by the Rideal-Walker test was advocated by S. Rideal in the section of hygiene. The sterilisation of potable water by hypochlorites was the subject of several communications to the same section. An interesting paper on the chemical reactions of micro-organisms was read before the section of biochemistry by F. Ehrlich, and several investigators presented communications bearing on the relationship between chemical constitution and germicidal or physiological action.

The utilisation of American natural gas has led C. Baskerville to study the chlorination of this cheap source of methane, and his results were communicated to a joint meeting of the sections of inorganic chemistry, photochemistry and electrochemistry. To the last of these sections were presented several papers on the electric smelting of iron, zinc and other metals, and on the electrolytic processes of producing chlorine, alkali and hypochlorite.

In the section of political economy and conservation of natural resources reference was made to the conservation of forests and water supplies, and to the utilisation of peat and coal waste.

Another important feature of the work of this congress was the delivery of four lectures of general interest by eminent chemists representing France, Germany, Great Britain and Italy. The great hall of the college of the city of New York, having a seating capacity of 3000 persons, was available for this purpose and for the general meetings of the congress.

Prof. Gabriel Bertrand spoke on the part played in agriculture by the minor constituents of plants. It has been demonstrated that the element manganese, present only in minute quantities in plants, enters into the composition of laccase, an enzyme, first extracted from the lacquer tree, which is capable of bringing about an assimilation of atmospheric nitrogen. Small additions of manganese have been found to increase crops to a considerable extent, and similar effects have been produced with other of the less common elements. These results lead to a new class of fertilisers—the catalytic manures—which are capable of modifying favourably the fertility of the soil.

Dr. Carl Duisberg lectured on the latest achievements and problems of the chemical industry. The problem of the utilisation of peat has received a solution in Frank and Caro's process of producing peat gas for heating purposes with recovery of the nitrogen as ammonia. Great strides have been made in the manufacture of refined steels containing other elements besides iron and carbon. The nickel alloys are of great value; those containing 23 per cent. and upwards of this metal are non-magnetic, whilst the 45 per cent. alloy has a coefficient of expansion not greater than that of glass. Steels containing chromium and molybdenum are remarkably resistant to mineral acids; the alloy containing 60 and 3 per cent. of these metals respectively is not appreciably attacked by boiling aqua regia. Steels containing chromium, tungsten and vanadium have a high degree of hardness. Vanadium steel is employed in forging high-speed tools, and the firm of Krupp have patented a steel which can neither be drilled, nor disintegrated by explosives, nor cut by the oxyhydrogen or oxyacetylene flame. Electrolytic iron, which is now manufactured free from hydrogen by electrolysis in hot solutions, can be magnetised and demagnetised more readily than ordinary iron containing carbon and silicon. Electromotors in which this material is used are two-and-a-half times as efficient as those constituted of silicon iron. The lecturer reviewed the recent developments in colour synthesis, pharmaceutical chemistry and chemotherapy, the treatment of infectious disease with chemical compounds. The production of non-inflammable kinematograph films ("cellite") and non-inflammable celluloid ("cellon") from acetylcellulose are valuable improvements which must eventually promote greater security of life and property from fire.

A controversial topic was reached when the lecturer dealt with the problem of the manufacture of artificial rubber. He asserted that F. Hoffmann, of the Elberfeld factory, is to be regarded as the real discoverer of synthetic rubber, this investigator having polymerised isoprene to rubber in 1909, a discovery which has been followed by the production of certain homologues of natural rubber. This view of the synthesis of rubber was subsequently refuted by Prof. W. H. Perkin in a lecture on the polymerisation of butadiene and isoprene, when reference was made to Tilden's discovery of nearly thirty years ago that isoprene polymerised to a substance identical with natural rubber. Specimens of Tilden's preparations were exhibited, and the lecturer gave an account of recent successful experiments on rubber synthesis starting from amyl alcohol made by a group of English chemists in collaboration with the French bacteriologist Fernbach.

The third general lecture was delivered by Prof. Perkin, who described the experiments which led to the fireproofing of the very inflammable material flannelette with precipitated hydrated stannic oxide, a treatment which renders the fabric ("Non-flam") permanently fireproof without affecting the colour of the dyed cloth, while its strength is increased by 20 per cent.

The fourth general lecture was delivered by Prof. G. Ciamician, who spoke on the photochemistry of the future and advocated the utilisation of radiant solar energy either directly in promoting photochemical change or indirectly by the intensive cultivation of plants yielding industrially valuable products, the harvested plants being subsequently converted economically into gaseous fuel and their mineral ash and recovered nitrogen being restored to the soil.

Closely allied to the subject of intensive cultivation were two addresses dealing with the fixation of atmospheric nitrogen. In the first of these discourses Dr. S. Eyde, who referred to the oxidation of atmospheric nitrogen, described the remarkably rapid growth of the synthetic nitrate industry of Norway and the methods employed in utilising the water-power of that country. In the second address Dr. H. A. Bernthsen gave an outline of Haber's process for synthesising ammonia, now being developed on a manufacturing scale by the Badische Anilin und Soda- Fabrik.

By operating with purified hydrogen and nitrogen under high pressure (200 atmospheres) at 650–700° C. in the presence of a suitable catalyst (iron, manganese, molybdenum, tungsten, uranium carbide, &c.), about 8–10 per cent. of the gaseous mixture is converted into ammonia, which is either separated by liquefaction or dissolved out by water.

In addition to the general lectures and sectional meetings, the social side of the congress was fully developed, and a special entertainment programme was arranged for the ladies accompanying the members and delegates.

At the close of the congress nearly 300 of the members proceeded on one or other of two tours arranged by Drs. Rosengarten and Day and other members of the special transportation and factory inspection committees. Two special trains were provided, and at each stopping-place local committees had been organised, the representatives

of which met the visitors and conducted them by rail or motor-car to factories, laboratories and other places of interest. The shorter of these tours took ten days, during which the party visited Philadelphia, Pittsburg, Niagara, Detroit, Chicago, Cleveland and Boston. The longer tour included a journey to the western and southern States, with visits to Salt Lake City, San Francisco, Los Angeles, Grand Canyon, Arizona, New Orleans, Atlanta and Washington.

The small band of British chemists who had the good fortune to attend this congress and take part in the excursions are unanimous in their praises of the splendid organisation and cordial generous hospitality experienced at every stage of their visit. American chemists are to be congratulated not only on a congress of great scientific interest and importance, but also on the unqualified success which invariably attended their praiseworthy efforts to entertain and instruct their guests. G. T. MORGAN.

PREHISTORIC MURAL DECORATIONS IN BACON'S HOLE, SOUTH WALES.

THE cave of Paviland (Gower, South Wales), first investigated by Buckland so long ago as 1823, has lately acquired a fresh interest in the light of recent discoveries made in France.

Most of the objects found by Buckland are exhibited in the Oxford University Museum, where they fill the greater part of a case devoted to the Aurignacian age. Among them are cylindrical rods (like lead pencils in size and shape) carved out of mammoth ivory, an ivory lissoir (*i.e.*, smoother), and some other rudely shaped pieces of ivory. Prof. Breuil, the greatest authority on Aurignacian remains, being on a visit to Oxford, made an examination of these objects last week and unhesitatingly referred them all to the Aurignacian age. There are also some fragments of a beautifully worked ivory ring, about the size and shape of an Indian bangle, or a little smaller; these also were assigned with equal confidence to the Aurignacian, precisely similar rings having been found in deposits of this age in France.

As a consequence of these results, Profs. Breuil and Sollas decided to visit the caves of Gower in the hope of finding some painting on the walls. A halt was made on the way at Swansea, in order to examine the rich collection of flint implements from Paviland which are preserved in its museum. These proved unusually interesting, and were for the most part identified by Prof. Breuil as Upper Aurignacian, a few being Proto-Solutrian. A systematic search was then made of the caves, beginning with Paviland, on the west, and working towards Bacon's Hole, on the east; as cave after cave failed to yield any signs of painting, hope began to wane, but, on entering Bacon's Hole, colour was seen on the right-hand wall. Closer examination revealed the presence of ten bright red bands, approximately horizontal or slightly divergent, fan-like, arranged one above the other in a vertical series, about a yard long, each band being perhaps a foot in length and one to two inches in breadth, but no exact measurements were made. The stalactite which has tapestried the wall is very clean and has completely sealed up the red pigment (iron-ochre), so that it cannot be removed by rubbing.

It is of interest to note that similar bands, similarly arranged, but only eight in number, have been observed at the end of the great gallery in the Font de Gaume of Dordogne.

It is to be hoped that a general search will now be made in our English caves for other examples of mural decoration; they may be easily passed over by the casual visitor, and to be seen must be looked for.

NOTES.

As already announced in these columns, a meeting is to be held at the Mansion House at 2.30 p.m. on October 23 to take steps to raise a fund for the establishment of a memorial to the late Lord Lister. Among those who will address the meeting are the Prime Minister, the president of the Royal Society (Sir Archibald Geikie, K.C.B.), the president of the Royal College of Surgeons (Sir Rickman J. Godlee), Lord Avebury, F.R.S., and the Hon. W. F. D. Smith.

THE Paris correspondent of *The Times* announces that the international conference on time reckoning was opened at the Observatory on October 15 by M. Guist'hau, Minister of Education; and M. Bigourdan, member of the Institute and of the Bureau des Longitudes, was elected president. The conference has been summoned mainly with the object of dealing with various practical uses of wireless telegraphy in the synchronisation of time signals throughout the world.

SIR GEORGE DARWIN, who recently underwent an operation, continues to make such good progress toward recovery that no further bulletins will be issued.

THE death is announced, at the age of fifty-eight, of Mr. F. H. Low, the honorary secretary of the Röntgen Society. Mr. Low was the medical officer to the X-ray department of the London Medical Graduates' College and Polyclinic.

IT is announced, through Reuter's Agency, that the Nobel prize for medicine for 1912 has been awarded to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research in New York, for his works on the suture of vessels and the transplantation of organs. The prize this year is said to amount to about 7800*l.*

A COURSE of six lectures on the properties and manufacture of concrete is to be given, by Mr. H. Kempton Dyson, secretary of the Concrete Institute, at the Concrete Institute, Denison House, Vauxhall Bridge Road, Westminster, at 5.30 p.m. on Tuesdays, beginning on November 12. The lectures are free, and tickets of admission may be obtained from the secretary of the institute.

A MEMORIAL service for the late Mr. H. O. Jones, F.R.S., fellow of Clare College, Cambridge, demon-

strator to the Jacksonian professor of natural experimental philosophy, and Muriel Gwendolen Jones, his wife, who were killed in the Alps in August while on honeymoon, was held at the University Church of St. Mary the Great, Cambridge, on October 12. The service was attended by a large congregation, which included masters of several colleges, University professors, and many other members of the University. The Royal Society, the Alpine Club, and the Cambridge Alpine Club were also represented.

THE council of the Institution of Civil Engineers has made the following further awards for papers read during the session 1911–12:—A Watt gold medal to Prof. W. H. Burr (New York), and the Crampton prize to Prof. R. J. Durley (Montreal). The following Telford premiums have also been awarded for papers published in the Proceedings without discussion during the same session:—To Messrs. Paul Seurot (New York), David Anderson, and Harry Cunningham (London), Dr. S. P. Smith (Birmingham), Mr. E. G. Rivers (Richmond), Mr. E. H. Morris (Manchester), and Prof. A. H. Gibson (Dundee). The Howard quinquennial prize for 1912 has been awarded to Mr. J. H. Darby (Sheffield), in recognition of improvements introduced by him in iron and steel production, and the Indian premium for 1912 to Mr. H. H. G. Mitchell (Madras).

THE nineteenth report of the Museum and Art Gallery Committee to the Town Council of the borough of Leicester deals with the period from April 1, 1910, to March 31, 1912, and provides an interesting description of two years' excellent work and progress. In addition to the Saturday evening public lectures, which have long been a successful part of the committee's work, a commencement has been made in the matter of lectures to teachers. The movement among educational authorities in favour of a more enlightened use of museums calls for a knowledge on the part of teachers of the contents of these institutions. In Leicester the curator has arranged a series of lectures to local teachers, intended to show how the contents of the museum may be used to instruct and interest children in the subjects illustrated by the exhibits. The report also points out that a small vivarium has been commenced and has proved a great attraction to visitors. Various living examples of British reptiles, batrachians, and invertebrates are on show, as well as two or three exotic forms.

A RECENT number of *The Journal of Tropical Medicine and Hygiene* (vol. xv., No. 17) contains an account of the investigations on the etiology of pellagra carried on by Drs. Sambon and Chalmers, for which financial support was generously provided by Mr. Henry S. Wellcome. There are two opposed theories in the field with regard to the causation of this disease; according to the prevailing view, that of the "zëists," pellagra is the result of poisoning by unsound maize; Dr. Sambon, on the other hand, believes the disease to be due to infection by a parasitic organism, propagated by the agency of Simuliidæ, small biting flies which breed in running streams. As the result of epidemiological investigations carried on in many countries, Drs. Sambon and Chalmers have brought together a considerable body of facts and observations which tend to disprove, on one hand, any connection between pellagra and a maize diet, and to prove, on the other hand, that all areas in which the disease is endemic are situated in close proximity to streams in which Simuliidæ breed. It remains, however, for the parasitic theory of pellagra to receive definite proof by the discovery of the parasite (provisionally assumed to be "protozoal" in nature), and of its transmission and life-history.

The Museums Journal for September contains a notice, accompanied by a plan, of the proposed extensions of the Natural History and the Science Museums, based on "White Paper" Cd. 6221. It is pointed out that the housing of the Geological Survey and its collections in an extension of the eastern end of the Natural History Museum ought to prove advantageous on account of leading to greater facilities of cooperation between the palæontologists of the museum and the officers of the survey. On the other hand, the trustees of the British Museum are supported in their objection to the proposed removal and rebuilding of the spirit building at the Natural History Museum.

UNDER the heading of "The Insect's Homer," Mr. Maurice Maeterlinck directs attention in the September issue of *The Fortnightly Review* to a little-known work by J. H. Fabre, in ten volumes, entitled "Souvenirs entomologiques." Fabre, it appears, was a native of Provence, where his memory has recently been honoured by a special celebration. According to the author of the article, he was "one of the most profound and inventive scholars, and also one of the purest writers, and, I was going to add, one of the finest poets of the century that is just past." In these volumes, from which copious extracts are given, Fabre recorded the results of fifty years of observation, study, and experiment on a number of insects, including wasps and wild bees, certain gnats, flies, beetles, and caterpillars.

IN the Bulletin of the American Museum of Natural History (vol. xxxi., p. 313) Mr. Abbott H. Thayer replies—and we venture to think very ably—to recent criticisms of his views with regard to cryptic and protective coloration in animals. After replying to objections that have been made against the protective nature of the "white-belly" type of coloration, the author directs attention to the extreme importance of the level from which the cryptically coloured animal is viewed. "An animal [such as a zebra] seen from a level above his own, has the dark earth for a background, while, at the very same moment, seen from two or three feet lower down [the lion's point of view] he has the bright sky instead, or is, at least, seen in the direction in which sky or glimpses of sky are to be expected. The moment this is understood, it becomes obvious that there is no such thing as a cryptic coloration *per se*, and that any amount of conspicuousness from all other view-points has nothing whatever to do with the question." The author illustrates this pictorially by means of a photograph of a "dummy" zebra and ass placed among thin scrub, and viewed from a lower level, when the former animal becomes practically invisible against the

sky-line, while the latter stands out sharply silhouetted against the same.

THE bright coloration of most Hemiptera is due to a fatty tissue known as pseudovitellus, and this tissue invades the developing egg at an early stage of maturation. Its significance has been variously interpreted, but only quite recently has its true function been discovered. Thanks to Sulc and Pierantoni, it is now known to be the habitat and to provide the food of multitudes of symbiotic organisms, probably yeasts. Every Aphis, every Psyllid, is a synthesis of two organisms, one the insect and the other the symbiont. Dr. Buchner, "Studien an intracellularen Symbionten" (part i., *Archiv f. Protistenkunde*, vol. xxvi., 1912), has taken up the detailed study of the range and nature of this form of symbiosis, and he gives a very interesting and well-illustrated account of his researches. Beginning with certain Coccidæ, in which the pseudovitellar cells may be present or absent (facultative mycetocytes), he proceeds to describe the definite organ (mycetom) which they form in Aphids and others. They may be infected by one kind of symbiont, by two kinds rigidly kept from commingling, or even (Psyllidæ) by three kinds. Similar symbiotic organisms are not limited to Hemiptera, and indications are given that they occur in cockroaches, beetles, Hymenoptera, and Lepidoptera. The organisms are carefully described, and the whole subject is one that deserves the fullest attention from botanists, and especially from mycologists. The relations between the insect and the symbionts are still in need of elucidation.

WE have received from Messrs. Gallenkamp and Co., Ltd., Sun Street, Finsbury Square, E.C., a copy of their new catalogue of apparatus for botanical laboratories (List No. 61). This catalogue, in which every requisite for the study of plant physiology is listed, with numerous illustrations of special apparatus for physiological experiments as well as of general laboratory materials, is indispensable to teachers of botany. The chief feature of the catalogue is the listing of the apparatus described in standard text-books on plant physiology; the portion dealing with botanical material and slides contains a rather large number of misprints in the names of plants.

MR. O. F. COOK has published an interesting note in the Journal of the Washington Academy of Sciences (vol ii., No. 9) on the morphology of the leaf in various members of the Prunus section of Rosaceæ, sometimes regarded as a separate family (Amygdalaceæ). The leaves of plum, peach, apricot, &c., have a joint at the base, just above the insertion of the stipules, as in many leguminous plants; the part below this joint does not fall off with the leaf-stalk, but remains alive and forms a supplementary bud-scale. This is regarded as a vegetative character which supports the view that the Amygdalaceæ are deserving of family rank, and also as strengthening the connection between the rosaceous and leguminous series. The fact that small leafy outgrowths sometimes replace the nectaries on the upper part of the leaf-stalk in various Amygdalaceæ suggests the view that the immediate ancestors of this family had compound leaves, these nectaries corresponding to the marginal glands of the leaf-blade and representing rudiments of divisions of compound leaves.

MR. F. W. CLARKE returns to the consideration of the average composition of various rocks in a paper on some geochemical statistics (Proc. Amer. Philosophical Soc., vol li., 1912, p. 214). His results give us an average igneous rock with a silica percentage of about 60, and the "surprising conclusion" (p. 227) that the volume of limestones in the crust is less than that of the salts dissolved in the ocean. The relation of these salts to the earth's age is again referred to.

DR. VAUGHAN CORNISH considers the origin of the Jamaica earthquake of January 14, 1907, in a short paper in *The Geographical Journal* for September. In his account of the earthquake published in the same journal for March, 1908, he shows that the destructive intensity of the earthquake was almost limited to a narrow zone crossing the island from near Kingston to Buff Bay on the north coast. The earthquake evidently originated in two foci, one near the mouth of the river Hope, a few miles east of Kingston, the other about ten miles to the north in the neighbourhood of the head-waters of the river at Hardware Gap. The earthquake could be assigned to no known fault, but, as shown by the small extent of the area of destruction, the depth of the foci must have been inconsiderable. Dr. Cornish therefore attributes the earthquake to the redistribution of stresses in the surface-crust through the action of river-denudation, the added load near the mouth of the Hope river causing a subsidence along a shallow-seated fracture, while the diminution of pressure among the mountains at Hardware Gap would, he thinks, result in elevation along another fracture.

THE report of the Sonnblick Society directs attention to the fact that in September, 1911, the Sonnblick Meteorological Observatory, at an altitude of 3105 metres, completed the twenty-fifth year of its useful work. It is the highest in Europe which has a resident staff all the year round, and was established by the Austrian Meteorological Society at the instigation of Hofrath Dr. J. Hann. At the end of 1892 it was in danger of being relinquished owing to the want of funds, when the Sonnblick Society was formed and came to its rescue by obtaining subscriptions, which are still continued. Later on the permanency of the establishment was assured by a Government grant in aid. The following data are extracted from the published results for 1911:—

	January	July	Year
Mean temperature (C.)	− 13·4° ...	2·2° ...	− 5·9°
Absolute maximum ...	− 4·4 ...	10·1 ...	10·1
,, minimum ...	− 28·5 ...	− 5·6 ...	− 28·5

The melted snow and rain for the year amounted to 1398 mm., on 229 days. Rain was only measured on a few days from June to September. Fog occurred on 230 days.

IN the Journal of the Meteorological Society of Japan (vol. xxxi., No. 7) Mr. G. Ishida describes some experiments carried out at Hamada with the view of improving the efficiency of storm warning signals at night. In the tests two kinds of oil lamps were used, provided respectively with circular and flat wicks.

Observers were stationed at various distances up to 5·4 kilometres from the signals, and naked-eye records were taken. There were three sets of experiments, to determine (1) the relative advantages of circular and flat-wick lamps; (2) the range of red and green lights; and (3) the distance at which two separate lights can be distinguished. The results showed (1) that the light from the flat wicks was considerably brighter at a distance than that from the round wicks, particularly when the line of vision formed a right angle with the sides of the wick, and (2) that the range of the red lights (flat wicks) was approximately double that of the green, the latter being scarcely visible at 3 kilometres, while the former were still bright at 5 kilometres. In the third set of experiments observations were taken at distances of 2 and 3 kilometres of pairs of lights separated by intervals of 2, 3, 4, and 5 metres. At 3 kilometres none of the pairs were distinguishable as separate lights when the space between them was less than 4 metres. With a separation of 2 metres red or green pairs were merged into one bright light. When red and green lights were shown simultaneously, the green light was eclipsed altogether by the red at 2 kilometres if the distance separating them was not more than 2 metres.

PART 15 of the *Verhandlungen* of the German Physical Society contains a description of a mechanical pump for high vacua recently devised by Dr. W. Gaede, which makes use of a principle not previously utilised in the construction of such apparatus. If a shaft revolving in a well-fitting bearing has a circular slot cut in it, the air in the slot will to a large extent be carried round with the shaft. If at one part the bearing projects into the slot so as to fill it completely, the gas in the slot will be carried round with the shaft from one side of the projection to the other, and the pressure will in consequence be less on one side than on the other. If two openings are made through the bearing, one on each side of the projection, air will be drawn in through one and delivered through the other. By making a number of slots in the shaft and connecting the openings into them in series, the action will be intensified. A pump constructed on these lines exhausts five or ten times as fast as one of Dr. Gaede's well-known mercury pumps taking the same power, and deals with the water vapour as well as the gas, so that no drying materials are necessary. As it works better at low than at high pressures it is run in conjunction with another pump, which reduces the pressure to a few centimetres of mercury.

IN a publication of the *R. Accad. delle Sci. dell' Inst. di Bologna*, which has recently come to hand, Prof. A. Righi describes some interesting experiments on the emission of ions in directions perpendicular to that in which the main discharge passes. Two wire electrodes are sealed into a cylindrical vacuum tube, perpendicular to the axis, with only their points exposed. When an impulsive discharge is passed between them it is found that ions are shot along the axis of the tube. The distance they penetrate and their relative numbers under different conditions are studied by collecting them in a suitably placed Faraday cylinder. By an ingenious arrangement of vanes, which rotate when the ions strike them, it is possible to follow the paths of the particles. This transverse emission of ions is most vigorous near the ends of the main discharge. When the tube is placed in a magnetic field parallel with its axis the neutral doublets, already investigated by Prof. Righi in earlier papers, are formed, and, as would be expected, the Faraday cylinder collects less charge. On the other hand, owing to the large mass of the doublets, the mechanical effects are increased.

AN article in *Engineering* for October 11 recalls the discussion of a few years ago on the distribution of shearing stresses on the horizontal layers of a dam. Messrs. Wilson and Gore showed experimentally in 1908 that the stresses did not follow a parabolic distribution, but were much more uniform. Prof. E. G. Coker has lately described experiments at the Royal Society on thin celluloid sheets under shearing stress, the conditions resembling that of the web plate of a plate girder. It has been contended that the shearing stresses in the girder web follow the parabolic law, but these experiments indicate that this law is only approached when the plate is shallow. Otherwise the shear curve had no maximum at the centre of the specimen, but showed two equal maxima, which are at points situated at a distance from the ends equal to rather less than the width of plate under test. Reducing the depth of the plate causes these two maxima to approach each other, and they finally coalesce when the depth of the specimen is about equal to its width.

A SECOND edition of Mr. T. H. Byrom's "Physics and Chemistry of Mining: an Elementary Class-book for the Use of Mining Students," has been published by Messrs. Crosby Lockwood and Son. In this edition the chapter on magnetism and electricity has been omitted, and additional matter has been introduced in both the physical and chemical sections. The price of the volume is 3*s*. 6*d*. net.

MESSRS. H. F. ANGUS AND CO., of Wigmore Street, London, have issued a new catalogue of second-hand scientific apparatus and accessories which are available for sale, exchange, or hire. We notice that all the instruments listed, unless otherwise stated, have been tested, adjusted where necessary, and are capable of work of equal precision as when new. Interesting particulars are given in the list of microscopes and accessories, as well as of various other optical instruments.

OUR ASTRONOMICAL COLUMN.

GALE'S COMET, 1912*a*.—London urban skies have remained comet-proof for some time now, but Mr. Franks, writing to *The Times* (October 15), reports that he saw Gale's comet very well, with a 6-inch refractor, during the week ending October 11, at East Grinstead. He states that it appeared to be brightening, for it was about fifth magnitude when he first saw it, and was nearer fourth on October 11. On this date it was a fine object, plainly seen in the finder, and, by sighting along the telescope, it could be seen by the naked eye as a misty spot about half a

degree below α Serpentis. When seen on a dark sky it presented an extensive coma with a large bright nucleus and a tail at least half a degree in length. Mr. Franks also reports that it was nearly a degree north of its predicted position on October 11, and that the difference is increasing, but it seems probable that he was using the earlier ephemeris published by Dr. Ebell, and not the later one from which we gave an extract last week. The following is a continuation of the corrected ephemeris :—

1912	α (true) h. m.	δ (true) ° ′	1912	α (true) h. m.	δ (true) ° ′
Oct. 18	15 49·9	+13 20·0	Oct. 22	15 54·1	+16 52·0
19	15 51·0	+14 14·6	23	15 55·1	+17 42·5
20	15 52·1	+15 8·2	24	15 56·1	+18 32·0
21	15 53·1	+16 0·6	25	15 57·0	+19 20·5

According to this ephemeris, the magnitude should now be 6·6, and decreasing slowly, but, as Mr. Franks remarks, the comet is exceeding expectations, and, with its indications of abnormal brightening, may well repay careful observation, especially in the form of a close series of photographs, by those who are favourably situated; on October 21 the comet will be about one-third of a degree east of γ Serpentis.

THE RECENT TOTAL ECLIPSE OF THE SUN.—It is with much regret that we learn from Greenwich that all attempts to make observations of the recent total eclipse of the sun were frustrated by the heavy rain which prevailed in the eclipse region of Brazil on eclipse day, October 10. The Greenwich observers, Messrs. Eddington and Davidson, were located at Alfenas, an elevated village some 185 miles north of Santos, where there were also eclipse parties from France, Germany, Brazil, and other countries. The Brazilian officials rendered all the assistance they could, and the Government voted a sum of 5000*l.* for the reception of the visiting astronomers at Rio. According to a characteristically interesting letter from Mr. J. J. Atkinson, which appeared in *The Morning Post* on October 8, the Greenwich equipment weighed about three tons, and had to be transported from Rio to the terminus of the State railway, a distance of about 150 miles towards the mountains; owing to the sharp incline the latter part of the track has to be worked on the cog system. Mr. Atkinson, who accompanied the Greenwich observers as a volunteer, also recites some interesting reminiscences of his previous eclipse experiences.

THE CONSTANT OF ABERRATION.—In No. 15, vol. xxvii., of *The Astronomical Journal*, Prof. C. L. Doolittle gives the result of twenty-two determinations of the aberration constant derived from thirty-two years' latitude work at the Sayre and Flower Observatories. The observations were made at two different places, with what are practically four different instruments, only the observer remaining the same, and the mean probable error is less than 0·01″. Taking the weighted mean of all the observations, Prof. Doolittle finds for the constant the value 20·525″ ± 0·0043″, and the corresponding value for the solar parallax is 8·780″.

THE AUTUMN MEETING OF THE INSTITUTE OF METALS.

THE papers presented at the autumn meeting of the Institute of Metals, which took place at the Institution of Electrical Engineers on September 25 and 26, may be divided into two groups according as their interest lies principally on the practical or on the scientific side.

Among the "practical" group two papers dealing with the joining of non-ferrous metals and alloys may be mentioned. In these Prof. Carnevali, of Turin, and A. E. Tucker, of Birmingham, discuss the question of autogenous welding, although the latter paper also deals in an interesting if somewhat scrappy manner with many other processes, such as soldering and brazing, &c. In view of the great extension of autogenous welding by means of oxygen and acetylene, the question how far the results of this process can be trusted is an important one. Tucker appears to regard a weld as satisfactory if it is found on testing it to destruction that the fracture occurs away from the weld itself. As a matter of fact, however, the weakest portion of a welded joint, as Carnevali points out, is not the weld itself, but the region of injured metal on either side of it. According to this author the strength of welds in copper and its principal alloys cannot be depended upon, and this conclusion agrees with the views on autogenous welds in iron and steel recently expressed by Fremont and others. In regard to pure aluminium, however, Carnevali finds the method to give satisfactory results, but the efficiency of a weld is much reduced as soon as it is applied to one of the stronger light alloys of aluminium. Broadly speaking, these papers lead one to view the rapid development of autogenous welding practice with some suspicion.

Still on the "practical" side were a number of papers dealing with impurities in copper and copper alloys. An interesting and suggestive paper by E. F. Law dealt with oxygen and oxides as deleterious impurities in alloys. This author took the view that progress in non-ferrous alloys was largely a question of the better elimination of oxides, and this view was strongly supported in the discussion by Rosenhain. The paper by Prof. Turner, however, emphasised the existing difficulties in the way of analytical determination of oxygen in brass, and an appeal was made to chemists to devise a satisfactory method for this purpose. F. Johnson dealt with the effect of impurities, chiefly antimony, on the properties of tough-pitch copper, and here again discussion centred round the part played by oxygen. The lenient view as to the deleterious effects of antimony put forward by the author was, however, strongly opposed by all those who have to deal with copper on the large scale. Other papers of a "practical" character dealt with high-temperature tensile tests on copper and its alloys, and with the annealing of coinage alloys, and both these papers were vigorously criticised in the discussion on the ground of the experimental methods employed by the authors.

The "scientific" papers were not so numerous, but of special interest. Prof. H. C. H. Carpenter contributed two papers dealing in further minute detail with the inversion which he has discovered in a certain range of copper-zinc alloys (brass) at a temperature of 470° C. In one of these papers the author deals with the effect of impurities on this inversion and finds that any addition of a third metal to these alloys tends to facilitate rather than to inhibit the transformation in question; since the change renders the metal weak and more brittle, it is evident that the use of the purest copper and zinc is desirable in the manufacture of those varieties of brass containing the constituent.

In a very short note Dr. G. T. Beilby, F.R.S., discusses the phenomena of the solidification of metals from the liquid state in reference to the "foam cell" theory of Quincke. In his May lecture to the institute, Dr. Bielby had suggested the importance of a full experimental investigation of the views put forward by Quincke, and the present note is intended to

state more precisely the problem which Dr. Beilby desires to see investigated. The fundamental question, which goes beyond Quincke's hypothesis, is this, whether the liquid metal undergoes any changes or separations before actual solidification commences, and, if so, whether there is really any formation of foam cells or analogous structures governing the crystallisation of the metal. In his note Dr. Beilby quotes some lines of evidence from the manner in which a thin film of fused salt or other substance solidifies on a glass slip which appears to be strikingly contradictory to Quincke's views, and indeed the impression derived from reading Dr. Beilby's note is rather that he finds the "foam cell" theory less attractive after thus considering it more closely. A practical result is, however, likely to follow from Dr. Beilby's interest in the matter, in the shape of an exhaustive report on our present knowledge of the passage from the liquid to the solid state in metals, prepared under the auspices of a committee of the Institute of Metals, and this will certainly be very welcome.

Of purely theoretical interest is the paper presented by Dr. Rosenhain and Mr. Ewen, of the National Physical Laboratory, on the intercrystalline cohesion of metals. In this paper the authors advance the hypothesis that the crystals of a pure metal are held together by the action of a thin layer of metal in the amorphous condition forming a species of cement between the crystals. The conception of the existence of such a cement has already been put forward by Bengough and by Osmond, but the authors claim to have used it as a working hypothesis in their own laboratory before others had published their views. The paper begins with a detailed discussion of the general facts which lead in the first place to the idea that there should be some special condition at the boundary surfaces of crystals in solid metals; perhaps the most striking of these facts is the strength of these bounding surfaces, since it has been conclusively shown that pure metals normally undergo fracture through the crystals and not along the boundaries between them; the cohesion across these bounding surfaces is thus stronger than that across the cleavage planes of the crystals themselves.

The authors next suggest in general terms that when two growing crystals approach one another, a region is formed at their boundary in which the molecules are no longer able to assume the crystalline arrangement, and they further point out that if the unit or element of which the crystal is built up is large compared with the "liquid" molecule, then at the junction of two crystals gaps must remain which are too small to contain another complete crystal unit and that consequently such gaps would ultimately be filled by undercooled liquid metal which had been unable to crystallise. This undercooled liquid would then be identical with the "amorphous phase" of Beilby, and would possess similar properties. The paper points out that Beilby has shown that the amorphous phase is more soluble in acids and possesses greater chemical activity than the crystalline phase, and it would accordingly possess a higher vapour pressure under corresponding conditions of temperature. It follows that if two pieces of the same metal, one containing a small and the other a relatively large proportion of amorphous matter, were heated to the same high temperature in a high vacuum, the one containing the larger proportion of amorphous matter would lose weight more rapidly than the other.

This conclusion the authors have submitted to the test of experiment in the following manner. If an amorphous intercrystalline cement exists, then a specimen of metal consisting of a few large crystals would contain less of this amorphous material than a piece of the same metal which consists of a very large number of minute crystals, since the material of the cement is chemically identical with the bulk of the metal. Specimens possessing large and small crystals respectively were prepared by the authors in various ways, and these specimens were heated in high vacua (0·005 mm. and under) at temperatures sufficient to produce considerable volatilisation losses,

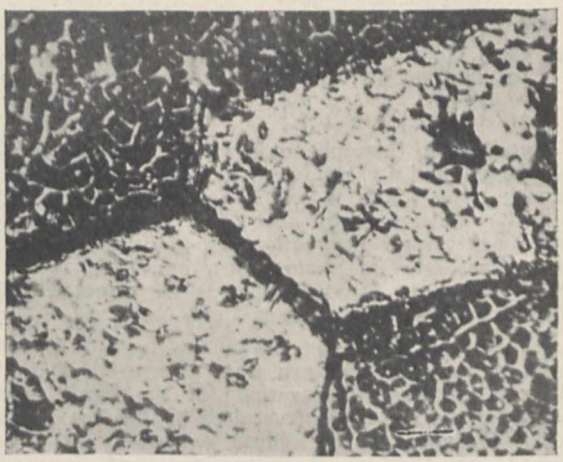


FIG. 1.—×100.

but still well below the melting points of the metals in question.

In the case of silver, zinc, and copper the authors found their expectations verified; the specimens possessing the minute crystal structure in every case losing weight at a greater rate than the coarsely crystalline specimens. The differences found were, in fact, considerably greater than the amount of amorphous cement which could reasonably be supposed to exist in the specimens, but although this point was

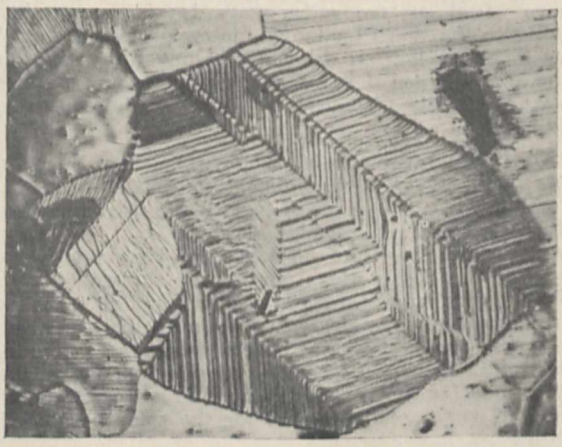


FIG. 2.—×200.

somewhat laboured in the discussion, the authors offer a fairly satisfactory explanation by showing that the formation of fissures due to the evaporation of the "cement" allows all the crystals in the fine-grained metal to undergo volatilisation from all their surfaces, so that after a time the effective evaporating surface of the fine-grained specimen is much larger than that of the coarse-grained.

This explanation is supported by microscopic evidence, since the widening—by evaporation—of the

intercrystalline boundaries is clearly visible on the specimens. An example of the channels formed in this way is shown in Fig. 1, reproduced from the paper. An interesting confirmation of the authors' views is further found in the fact that while the boundaries between adjacent crystals always exhibit this deep channel, the boundaries of twin-crystals do not show such a groove; since the crystal units on either side of a "twin" boundary fit into one another in a regular manner there is no room for amorphous matter in these boundaries, hence the absence of the groove. With the metals antimony, cadmium, and aluminium the authors obtained irregular losses of weight which neither confirmed nor refuted their views; they put these views forward merely as a suggestive working hypothesis, and do not claim to have furnished a valid proof of its truth.

Incidentally, the method of heating metals in high vacua furnishes an interesting means of developing their micro-structure, and this method has been used by the authors to study the conditions under which twinned crystals are developed in silver. One of their photomicrographs showing the structure of a twinned crystal of silver is reproduced in Fig. 2.

THE SURFACE-TENSION OF LIVING CELLS.[1]

PROF. CZAPEK'S pamphlet contains most important experimental work upon one of the fundamental physical attributes of the living protoplasmic cell, namely, the surface-tension of its external limiting layer. He makes it clear that the tension conditions obtaining in this layer, which intermediates between each metabolic unit and its environment, are of great significance for secretion and for absorption, and he has established that the surface-tension of the cells of the higher plants is maintained fairly constant at the value of about 0·685, the surface-tension of water in contact with air being taken as unity.

This very important conclusion is the outcome of a line of research which began at an apparently remote point, the successive stages of which may be briefly set out. The work started with the investigation of the curious precipitates that could be produced in the living cells of many plants by the action of dilute ammonia or 0·2 per cent. caffein, such as had been described as "aggregation" by Charles Darwin, in the tentacles of Drosera. Czapek first established that this "myelin-like" precipitate is a compound of caffein with the soluble tannin of the living cell, and is produced in all cells that contain tannin, the mesophyll of Echeveria and Sedum being the most suitable material. He then found that if such living cells are immersed in solutions of organic substances for some hours, the power of giving a precipitate with caffein may be entirely lost. This loss was traced to exosmosis of the tannin from the living cell, and it was further found that for each organic substance there was a particular limiting concentration below which no effect was produced and above which the exosmosis became very rapid. On comparing these limiting concentrations for the series of monovalent alcohols it was found that at each step in the homologous series the molecular concentration required diminished to one-third. Such a relation was, however, exactly what Traube had established for the surface-tension effect of the members of this series.

[1] "Ueber eine Methode zur direkten Bestimmung der Oberflächenspannung der Plasmahaut von Pflanzenzellen." By F. Czapek. Pp. iv+86. (Jena: Gustav Fischer, 1911). Price 2.60 marks.

Following up this clue, Czapek measured the surface-tension of a large number of solutions of organic substances, and compared their action in causing exosmosis from the cell with their activity in lowering the surface-tension of water. He thus was able to establish securely the unexpected generalisation that *on dissolving in water sufficient of any organic substance whatever to lower the surface-tension to about 0·685, a solution is obtained which just causes the exosmosis of the contents of living cells.* The critical concentration may require twelve to twenty-four hours to produce its effect, but stronger solutions with a lower surface-tension work very quickly and thoroughly, so that after a short time treatment of the cells with caffein gives no intravital precipitate at all.

The power of the protoplast to retain its dissolved contents is thus shown to be a matter of physical organisation, depending upon the surface-tension of the cell being below that of the medium in contact with its outer surface.

From true solutions Czapek passed to try the effect of emulsion-colloids of a lipoid nature (proteids and carbohydrates do not lower surface-tension enough to give the critical value of 0·685). The lipoid emulsions are, however, extremely active, and give exactly the same effects as true solutions.

The last step in the progress was an attempt at identification of the substance actually present in the plasmatic membrane which causes it to have normally so low a surface-tension as 0·685. Czapek finds that saturated emulsions of neutral fats lower the surface-tension just to this value and no further, so that it seems very probable that these are the effective substances in the living cell.

We have thus striking support for the view, widely adopted from the work of Overton and Meyer, that the plasmatic membrane is of a lipoid nature. Overton's later view was that lecithin and cholesterin rather than neutral fats were the particular lipoids present, but these give a lower surface-tension down to about 0·5. The present line of work indicates that these may be the effective substances in some cells, not those of the higher plants, for yeast and red-blood corpuscles require a medium of about this lower surface-tension to bring on exosmosis of invertase and hæmoglobin respectively.

Many supporters of the lipoid theory of the constitution of the plasmatic membrane have interpreted it to mean that there exists at the surface of the cell a continuous film of a lipoid nature, and this has raised difficulties in understanding the intake of typical nutrient substances which are freely soluble in water, but not in fat. Czapek points out that an emulsion containing only a small percentage of fat is all that is needed to endow the cell with the observed specific properties.

Willard Gibbs showed from thermodynamical considerations that substances in a solution which strongly reduce surface-tension must accumulate in the surface-layer until their return by local excess of osmotic pressure produces a state of equilibrium between the surface and the mass. With emulsified fat particles, however, the osmotic pressure is very slight, and very great accumulation in the surface-layer must result.

This piece of work may serve as a model of scientific method on account of the way in which the mysterious phenomenon of "aggregation," described by Charles Darwin, has been followed on and on until it has led to the evaluation of so fundamental a vital constant as the surface-tension of the living cell.

F. F. BLACKMAN.

THE BRITISH ASSOCIATION AT DUNDEE.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY PROF. JOHN ADAMS, M.A., B.Sc., LL.D., PRESIDENT OF THE SECTION.

An Objective Standard in Education.

OF those who deny to education a place among the sciences the name is legion, for they are many. The mere classification as a science is not perhaps of much consequence, but it is useful for the student of education to examine the popular view, and see how far it is justified. The following statement, the words of a former occupant of this chair, will be generally accepted as representing the prevailing opinion:—

"If we take science to mean, as commonly understood, organised knowledge, and if we are to test the claim of any body of facts and principles to be regarded as science by the ability to predict, which the knowledge of these facts and principles confers, can we say that there exists an organised and orderly arrangement of educational truth, or that we can logically, by any causative sequence, connect training and character either in the individual or in the nation? . . . It is very doubtful whether we can say that educational science is yet sufficiently advanced to satisfy these tests."

First, with regard to organised knowledge, there is certainly a great mass of matter available in the subject of education. It is true that there is nothing easier than to show that this matter is not at present well organised. It is only too easy to find examples of contradictions among those who make a study of education and venture to write or speak on the subject. We are told that there is scarcely any important statement made by a writer on education that cannot be met by a direct contradiction in the works of some other educational writer. It has to be admitted that writers on education in the past have been strangely opinionative and dogmatic in view of the very complex and delicate problems they have had to handle. Too frequently they assumed a simplicity in their subject-matter that was certainly not there. Even the massive common sense of Dr. Johnson was not able to keep him from regarding education as a study that had reached its limits long before his time. But between those who regard education as too simple to need any further examination, and those who treat it as so complex as to defy human analysis, there are those who take the view that education is a science like any other, though they admit that there may be room for wide difference of opinion regarding the stage of development it has reached.

At the present moment it is becoming increasingly evident that educational theory is consolidating: it can now be claimed that there exists a great body of educational doctrine that is of general acceptation. It need scarcely be said that there are many and deep differences among the various schools of educational writers. But if we compare any two schools we shall find that the points of agreement far outnumber the points of difference. This was true even in the older times of naïve theory, but is making itself very evident in these latter days. Anyone who has occasion to read all the books on the theory of education as they appear is impressed in spite of himself by the large body of doctrine that is common to them all. It is not that the books lack originality: each writer has his new point of view or his new interpretation of certain phenomena; yet each either baldly states or tacitly takes for granted a great body of truth that is held to be generally accepted. This body of recognised truth is gradually increasing as the result of collective thinking and the corrections involved in active criticism. Already critics are beginning to find fault with any writer who produces a book—not avowedly a text-book—that professes to deal with the whole range of education. He is reminded that what is now wanted is a special development along certain definite lines. The general principles of education are held to be established and accepted.

In confirmation of what has been said, it may be added that within the past year or two have appeared no fewer than five separate treatises each bearing the same title: "The Principles of Education." These books are mainly for the use of students, and contain what are regarded as the accepted results of educational investigation up to the present date. Their authors obviously recognise the existence of a certain body of truths on which all are agreed. In some of the professions it is customary to speak familiarly of "the books," meaning the standard works to which appeal is constantly being made. If among teachers we have not yet reached this stage, we are obviously far on the way towards it. The books are there, but the profession needs some time yet before, in its own deliberate way, it recognises their importance. By and by it will realise the fact that it has at its disposal material that will enable it to prophesy, and thus fulfil, the second condition imposed upon all who lay claim to scientific knowledge. It is true that in the past there was little diffidence about prophesying: it was the fulfilment that gave trouble. Wolfgang Ratke supplies, if not the first, at any rate the most dramatic application of a control test in the working of educational prophecy. He went to prison because the people of his time did not make allowance for the insufficiency of the body of knowledge on which he based his predictions. There was indeed nothing scientific about the procedure of Ratke. He was at the empirical stage, and could not rise above it. His modern fellows have not quite got beyond the empirical, but they are on their way.

No claim is here made that Education has yet justified her demand to be recognised as a fully developed science; but it may be fairly maintained that she has at least entered upon the stage of scientific method: she is seeking to free herself from mere empiricism. In such a struggle there are at least two possible lines of action.

The first requires some ingenuity, but is natural and pleasant. It consists in superimposing principles upon the facts of the case. The educational theorist invents or assumes certain broad general principles, then proceeds to fit in all the observed facts, and often shows great skill in the process. This method is of very general application. Sometimes it is worked consciously and deliberately, as in the case of Socrates' doctrine of Reminiscence. Here we have the whole scheme of teaching simplified by this superimposed generalisation. Quite frequently, however, the broad underlying principles are not brought to clear consciousness, and are, in fact, sometimes contradictory to each other. Examples may be found in Rousseau. For our present purpose this tendency towards what may be called rational pedagogy is best illustrated in the system of education elaborated by Herbart. Though the metaphysical basis on which he builds is generally regarded as false, it was deliberately adopted by him, and if it is once granted to him, all the rest of his system must be admitted to be built up on strictly scientific principles. It is true that while logically Herbart's pedagogy was built upon his psychology, in point of fact his peda-

gogical thinking preceded and dominated his psychological theory. While Pestalozzi sought to psychologise education, Herbart may be said rather to have educationalised psychology. In any case, he supplies us with a system that challenges recognition as scientific, whether the claim be admitted or not.

The other method by which a study may seek to escape from mere empiricism is by dealing with observed results so as to reach the underlying principles. In this method, instead of setting up principles and making the facts square with them, we examine the phenomena and seek to discover the underlying principles. Obviously this at once introduces the experimental method, since no satisfactory progress can be made by mere passive observation. This is the stage we have now reached in educational theory. We are passing from an appeal to experience to an appeal to experiment. Naturally, educational method has always had to stand or fall by its results, but in estimating results there has too frequently been a confusion between cause and effect. So soon as a conscientious analysis of educational problems is attempted, there comes the need of experiment. Certain questions have arisen demanding a definite answer, and the answers supplied must stand the test of practical application. Education is, in fact, called upon to prophesy, and to stand or fall by the results. Now the method of experiment is really a system of tentative prophecy, under rigidly determined conditions. We acquire skill in prophesying by a process of trial and error. We become prophets by prophesying. From all the knowledge at our disposal we calculate that a certain process will give a certain result. We apply the process, and then if the result is not what we expected, we examine all the conditions, seek out the cause of our error, and proceed to another tentative prophecy. By and by we acquire the power of prophesying with confidence within certain recognised limits, and within those limits we may claim to proceed scientifically.

But in the evaluating of results that is necessary in this process of training in prophecy there is need for some recognised standard. Unless this condition be fulfilled there can be no general agreement among investigators. Accordingly, the first step in raising a study to the scientific level is the establishment of such a standard. In the study of education in the past—and it must be admitted that the same is true to a large extent at the present—the standard adopted was in most cases a subjective one. There is a tendency to have everything determined by individual opinion. Certain educational processes are gone through; certain results follow in the lives of the educands. The casual relations involved are arranged by the individual observer to suit his own views. According to some, the battle of Waterloo was won on the playing-fields of Eton; according to others, the battle of Colenso was lost there. We have need of some standard that is independent of private opinion.

Obviously the whole question of the relativity of knowledge is here involved. The educator is too apt to apply to his own case the Protagorean view, and maintain that "man is the measure of all things; of things that are, that they are, and of things that are not, that they are not." Into this antique problem we need not here enter. There is a sense in which the epigram of Protagoras may be justified. Without doubt, for his own practical purposes, the individual is the measure of his universe of experience. But so far as his universe has to do with the universes of others, the individual needs some common standard, something outside of himself, something that others besides himself recognise—in short, an objective standard.

The matter may be illustrated by what took place in the development of certain of the sciences. The secondary qualities involved in the Lockean epistemology—such things as colours, tastes, smells, sounds—lend themselves to a subjective standard; but so long as we confine ourselves to a standard of this kind we cannot be said to treat such matters scientifically. The individual is the sole judge of how a particular sound or colour strikes him, and against his decision there is no appeal. But it seems as if we could not have a science of sounds or of colours based on this individual judgment. Each observer would rely upon his own sensations, and would interpret them in his own way. Fortunately, in the study of physics it was discovered that certain of the conditions of sensation are constant. When we get a knowledge of wave-lengths, and the laws of refraction and reflection, we have passed from the merely subjective sphere, we have an outside standard, we can compare, abstract, and analyse independently of the individual. "C natural" has a definite meaning to science, even if there were not a single ear that could hear the sound. It is true that, in the ultimate resort, we cannot eliminate the individual observer. He is too important in ordinary life, and a great deal of the work of science is done, after all, at his address. How *red* strikes an observer is as important to a man of science as is the exact wave-length that is necessary to produce *red*. The relation between a certain wave-length and a certain sensation is complicated by the individual peculiarities of the sense organs of the living being concerned. In certain respects the science of optics is self-contained, and has a definite objective standard. In certain other respects it depends for its data on individual experiences, and has to content itself with a subjective standard. No doubt it can call in the aid of physiology, a science that has an objective standard of its own, and in this way eliminate a certain amount of subjectivity. But in the last resort there is a corner of the field in which no objective standard can be obtained.

It is true that in pure mathematics we appear to get into a region where the subjective may be practically excluded altogether, but even here the science of space and time is limited by the fact that it can deal with its data only from the point of view of human limitations. And there are certain borderline studies that are mathematical in their essence, yet have a direct reference to our bodily organs. Linear perspective, for example, is usually regarded as a science, indeed, as an exact science. Yet when we look into the matter we find that linear perspective is nothing more than a conventionalised method of treating, in an exact way, the results of individual experience. The whole science is really an objective standard by which the ordinary processes of vision may be compared, analysed, and classified. Perspective tells us what we ought to see. It is not independent of our sense functions, it is only a mode in which the variable subjective is reduced to uniformity by the application of the objective standard. Indeed, in the teaching of art there sometimes arises a curious conflict between the subjective element and the objective. Students who have studied perspective before they are called upon to draw real objects set before them are very apt to draw according to the rules they have learned, instead of observing what is actually before them and reproducing that as it appears to their senses. In other words, they set up the objective standard as paramount. So markedly is this the case that sometimes the study of perspective is forbidden until familiarity with model drawing has been attained. When a teacher urges a pupil to draw

what he sees, and not merely what he knows from the rules of perspective he ought to see, we have an appeal to the subjective standard. The teacher is turning from the science of perspective to the art of drawing.

This illustration is of particular advantage to us in our present work, because it not only exhibits the subjective standard working alongside of the objective, but it introduces the idea of an *exact* science in relation to our human organs. Astronomy is an exact science, and yet the problem of the "personal equation" shows that even here the subjective must be taken into account. The "personal equation" is, in fact, nothing but the elimination by quantitative methods of the disturbing subjective elements. It is by similar methods that we must seek to establish an objective standard in education. The difficulty in this subject is very great. Astronomy and physics touch the subjective only at what may be called the point of application—the point at which they are brought into contact with human life. Their subject-matter is external, and lends itself to objective treatment. In education the subject-matter is human nature, which is so complex and involves such volatile elements that it is almost impossible to reduce its working to fixed laws. The same difficulty obviously applies in psychology. Itself a comparatively new subject, psychology has great difficulty in getting recognition as a science. For this there are two main reasons. To begin with, psychology began life as a branch of philosophy, and scientific men regard with suspicion anything that comes from that quarter. Besides, there was the less reason to make room for the new subject, since it had already a settled place in the hierarchy of studies. The second reason is that which interests us here—the difficulty of establishing an objective standard. The descriptive generalities of Dugald Stewart and Thomas Brown had to give way to something based upon laws that are generally accepted. The line of least resistance in seeking for an objective standard in psychology is to fall back upon a physiological basis. It is generally admitted that nerve action can be referred to an objective standard, and by correlating psychic and bodily phenomena psychologists are able to get a series of recognised principles on the physical side that may be easily interpreted in terms of spirit. Psychophysics has at least a plausible claim to rank among the sciences, and the unbridged gulf between mind and matter is conveniently ignored. As a matter of fact, such a generalisation as the Fechner-Weber law ranks parallel with the laws of linear perspective—that is, it is a law that states in an unjustifiably exact way what ordinarily takes place in the individual experience. While rejecting the materialistic alliance, Herbart, as a psychologist, deliberately set up a mechanical system of ideas as forces, and in this way established at once an objective standard by means of which all mental process may be understood and manipulated. So scientific is his system that he claims that the interaction of the ideas may be calculated in certain cases by a simple application of the rule of three. With Herbart, psychology has certainly been raised to the rank of a science; but unfortunately it has to be admitted that his objective standard has been illegitimately assumed.

Just as psychology utilises physiology in its effort to gain a standing as a science, so education is inclined to use psychology. Frequently we hear psychology described as a science, while education is relegated to a place among the arts. It is natural, therefore, for the educator who wishes to claim rank in science to appropriate the scientific status of his auxiliary science. As a matter of fact, education has captured psychology. This is only one of many cases in which a profession has taken possession of an abstract study, and in this way enabled the abstract study to make real progress. Theology as a study has gained greatly by the fact that it is a compulsory subject for those who are preparing for a great profession. Astronomy owes a great deal to the support it has received from its practical value to navigators. Physiology would not be what it is to-day had it not become an essential subject in the preparation for the practice of medicine. Physiologists sometimes complain that their subject is hampered by its professors having to waste time in teaching mere medical students; it is well to remember, however, that but for the demands of the medical profession physiology would have been left to the few private investigators who might be able at their own cost to carry on under adverse conditions the work that is now being done in thousands of well-equipped laboratories. In the same way it is greatly to the advantage of psychology that it has become an essential part of the professional training of teachers. The subject is now receiving an amount of attention that it would never have had but for the support of its connection with the profession of teaching. But after all a teacher is not a mere psychologist: education is more than applied psychology. If education is to rank as a science, it cannot be in virtue of its use of another study that itself has an insecure foothold among the sciences. It must establish for itself an objective standard.

Mere quantitative manipulation of the elements of a study, if only carried out on a sufficiently large scale, has a tendency to evolve an objective standard, apart from any deliberate search for such a standard. We may gather something from an examination of a standard of this kind that, unexpected and unsought, evolved itself in the ordinary course of educational administration. What Binet and his colleagues and followers have been trying to do of set purpose was, to some extent at least, accomplished automatically by the working of the system of individual examinations under the English and Scotch codes of elementary education. Binet has drawn up certain tables with the express purpose of testing the intelligence of children at various ages. But we are only at the threshold of investigation work of this kind, and the tests cannot be regarded as satisfactory, either in themselves or in their application. But they have been drawn up with the deliberate purpose of supplying a more or less objective standard of intelligence. Now in the British elementary school codes we have the examination requirements from the pupils of different ages set out in a series of tables each corresponding to one of the seven grades known technically as "standards." The purpose of these tables of requirements was not primarily to determine the intelligence of the pupils, but rather to indicate certain minimum amounts of information that had to be communicated in consideration of a certain money payment. Yet these tables bear a generic resemblance to those of Binet, and in actual practice the "standards" did win acceptance as a test of intelligence. The requirements were perhaps less scientifically determined than are those of Binet's tests, but their practical value was very much greater, because of the extremely wide range of their application.

When the codes had been in working order for a score of years it became evident to thoughtful observers that there had arisen a standard of comparison among pupils in elementary schools that was gradually being recognised all over the country. It was an objective standard as was shown by the fact that each of the standards began to have a meaning of its own, apart from the individual school in which a particular pupil happened to be found. No doubt there were differences

in detail. A Standard III. boy in one school would be found to have greater knowledge and skill than a Standard III. boy in another. But the important point is that the phrase "a Standard III. boy" came to have a definite meaning apart from any particular school. It began to be used absolutely, and not merely relatively. Further, if a boy were found to be in a standard lower than his years warranted, people had no diffidence in drawing their own conclusions regarding his ability. It will be remembered that Binet tells us, somewhat vaguely, that if a boy is a year behind others of the same age who have had the same opportunities, it indicates that he is duller than the others, but not necessarily permanently so. If, however, the pupil is two years behind the normal test for his age there is a presumption in favour of his being inherently and permanently duller than his fellows. All this is very familiar and indeed commonplace to the elementary teachers who were brought up under the code examinations by standards. To tell the truth, M. Binet's tests are regarded with much suspicion by such elementary teachers as have been induced to give them attention. They have the feeling that here we have a university professor working out as something new a belated scheme that has had its day, and in that day done a great deal of damage. They are afraid that the prestige given to the intelligence tests may encourage the re-establishment of the rigid individual examination system from which they have escaped. All the same, experienced elementary teachers do not deny that the old system did at least have the effect of establishing a generally recognised standard. Their belief is that the standard was not worth what it cost.

It is left for Binet's successors to invent a better scheme than he was able to produce, and in this way to establish an objective standard, at least in respect of intelligence. Such a standard is needed in many connections, but there is one special department of educational administration where such a standard is at present urgently required. Nothing better illustrates the groping of education after a scientific basis than the present demand for some means of determining which children are "defective" and which merely dull. So imperative is the need for an objective standard here that it must be satisfied at any price, with the result that the decision is being more and more left to the doctors instead of to the teachers. The cause is not difficult to find. Physiology has already an objective standard, and the doctors are evidently expected to get their results by physical examination. No other explanation is admissible, since they are not only not superior to teachers in their knowledge of the mental reactions of the child, but obviously inferior. At present the argument moves backwards and forwards. Some say: Give the teachers a tincture of physiological knowledge, and then they will manifestly be the best persons to determine the defective stage. Others reply: Give the medical men some little experience of school conditions and the working of the immature mind, and they cannot but be the proper authorities on all questions of intelligence. The important point in this competition for power between the two professions is the implied recognition of the need for an objective standard, and the admission that, at present, such a standard does not exist. Much investigation, experimenting, and verification are necessary before the truth on this particular subject can be reached. But the recognition of the existence of the problem is in itself an indication of progress, and the need for scientific method in working it out is being more fully recognised. From our point of view it is important to note that we are here dealing with a problem that is distinctly educational, and the bringing in of men from another profession does not make it less so. If the doctor acquires the power of dealing with delicate questions of intelligence, it is because he has learnt to be an educationist if not an educator. Medical men who specialised in this matter would no doubt very soon attain to high skill, since their previous training gives them a very suitable preparation to begin the study of education. Doctors are consulted regarding "defectives" mainly for two reasons. First, these defective children are naturally classed in the popular mind with the mentally deranged, and these have always been regarded as peculiarly suitable subjects for the doctor. Further, there exists, without doubt, the implicit feeling in the public mind that the doctor has definite standards while the teacher has only general impressions. But it has to be noted that this invasion of the field of education by men from another realm of study does not in any way affect the claims of education to rank as a nascent science with needs and methods of its own. If the doctors can supply education with an objective standard, education should be very grateful, but need not abdicate in favour of medicine. Education may use the results of both psychology and physiology without in any way surrendering its claims to be an independent science. We must not, of course, make too much of the distinctions among the sciences. Nothing but error can result from seeking to make each of them rigidly self-contained. So far as education is concerned, what we have to seek is that objective standard that we have conceded to be essential to the recognition of a study as a possible science, and this without falling back on the standards of either pure psychology or pure physiology.

We may learn something from what we have found out about the results of the individual examination system. The general tendency of quantitative methods is to eliminate the subjective element. Even in the case of marking examination papers experience shows that the use of numerical marks tends to objectify results, and to get rid of some at least of the difficulty involved in the personal equation of the examiners. Marking by general impression of a whole paper is much less free from subjective variation. Every individual number set down as a mark implies a fresh exercise of the critical power, and when there are many questions there is a compensating principle at work, inasmuch as each impression is recorded as it is made and the addition of the marks produces a balancing in which the latest impression has not the determining influence it too frequently has when a paper is marked as a whole. If an examination includes many subjects, many examiners, and a great body of examinees, the subjective element in the marking is, to a large extent, eliminated, and we can deal with the results in accordance with what is practically an objective standard. We must not, of course, neglect the fact that after all the whole basis of the results is the judgment of the individual examiner on the material submitted to him. This corresponds to the application to real life of any of the physical sciences. Here, as in many of the other sciences, we have a surd of subjectivity that can never be got rid of entirely. But its disturbing influence can be minimised by the counteracting influences of other forces in the quantitative manipulation of the data.

Of late the quantitative method of dealing with educational problems has been greatly developed. Karl Pearson's product-moment formula has enabled us to make an accurate arithmetical statement of the amount of correlation that exists between series of quantitative data. By the application of this formula, and the simpler formulæ of Professor Spearman, it is now possible to correlate a great many facts that were formerly treated as having only a problematic connection with each other. If these formulæ produce really trustworthy results, we have at our command a means of answering definitely and definitively a great number

of questions that have hitherto been regarded as the more or less legitimate matter for the professional controversialist. The vexed question of "formal training," for example, may be set at rest once and for all by a sufficiently extended series of correlations of the results of pupils' progress in certain subjects. The peculiarity of this method of dealing with correlations is that once we have handed over our facts to the formulæ, the process passes out of our hands altogether. We have only to work out our equations and the results make their appearance. Here we certainly seem to have reached an objective standard.

Such results, however, are not unnaturally regarded with some suspicion. Once the formulæ have been established by mathematical proof they must, of course, be accepted as irrefutable on that side; but their application to educational problems is so mechanical and indeed inhuman that many are unwilling to accept and use them. Some people are doubtful whether, in dealing with human beings, it is desirable, even if it were possible, to have an objective standard that eliminates humanity from all human problems. It has to be pointed out to such critics that all human problems must begin with the individual and end with the individual. All the intermediate process may be carried on in the pure objectivity of quantity, without dehumanising the application of its results. This will be kept in view when we deal with the average.

Apart from the danger of dehumanising our subject, there are two real possibilities of error in the application of the formulæ. First, there is the danger that the investigator may be satisfied with an application to an insufficient number of cases. The second danger is that the subjective element may cause error in the preparation of the data. If the first possible source of error be minimised, the second will be practically removed. Granted a really wide investigation, there is little room for serious error. If a sufficiently large number of cases be examined, and these cases selected under sufficiently varied conditions, the subjective variations will neutralise each other, and a trustworthy result will be produced. It must never be forgotten that the Pearson and other formulæ are merely means of dealing with material already acquired. It is only to this extent that they supply an objective standard. Many of the recognised sciences are in no better case.

The hope of the evolution of education as a science lies in the proper manipulation of the method of experiment. Students of education have always been in the habit of asking questions, but they have not always waited for an answer. Nor have they usually taken sufficient care in making their questions precise. They have not laid down with the necessary detail the conditions implied in the question, and when they have reached some answer they have been too often content either to accept it without any verification at all, or with the support of nothing but a few general considerations that seemed to confirm it. In the newer educational investigations questions are set out in great detail. They are usually limited to one point, and all the relevant conditions are carefully laid down. Various control tests are applied during the progress of the investigation, and every precaution taken against the introduction of interfering forces. Then when a result has been obtained various confirmatory tests are applied. Even when all has gone well so far the result is not regarded as authoritative until the experiment has been repeated with the same results by different experimenters working under different general conditions, though, of course, all the detailed conditions must be precisely the same as in the original experiment.

The questions asked are often of a very practical character. In the current number of *Child-Study*, Mr. W. H. Winch gives an example. The question is whether one gets better results in working "problems" in arithmetic by (*a*) direct teaching for a certain period in how to work such problems; or (*b*) spending the same period in giving the pupils practice in working such problems. Mr. Winch gives a very instructive account of all the conditions under which his experiment was carried out, including all the necessary precautions. The result is that those who had had the teaching scored an average of 11·1 in the final test, while those who had had the practice scored only 9·2: the group that was taught improving on its preliminary record to the extent of 34 per cent., while the group that had been confined to practice improved by only 11 per cent. It is thus demonstrated, at present, that teaching counts for more than practice in the preparation of pupils to do problems in arithmetic. But the fact cannot be regarded as a part of the permanent possessions of the teacher till it is verified by many more experiments in this country and abroad.

We have seen that even at our present stage of advancement there is quite a respectable collection of recognised facts in connection with teaching and education, and that these are in process of organisation. We shall soon have such a volume of well-arranged knowledge as shall meet the first requirement for recognition as a science. But while organisation is imperatively needed and must go on, there is an equally urgent need for new knowledge. There are hundreds of definite practical questions that are being asked by teachers every day, and unfortunately answered according to individual experience, if not indeed according to individual caprice. Some few questions about the memory are now definitely answered, and practical educators have the benefit of the results of experiments; but there are scores of points with regard to memory on which there is still doubt, and yet these are points on which the practical educator must adopt a definite line in his daily work. He cannot postpone his decision: he must do one thing or another, and in the meantime he has no standard. Such investigations as are being undertaken by the committees of this section are helping to increase the total body of knowledge at present available. It is true that hitherto these investigations have been mainly concerned with psychological matters, and certainly our store of psychological knowledge is not so great as to warrant any complaint at the concentration on this aspect. But it is pleasant to note that this year we are having a report on more distinctively pedagogic matters. There could be no more useful subject of inquiry suggested than an investigation into the questions that are most urgently demanding answers at this time among the practical educators of the country. To discover and classify these, and then to correlate them with the various investigations that are being made throughout the world, would be to render a very practical service to the study of education. The truths thus acquired and recorded could be fitted in to the mass already at our disposal, and the result would be a great strengthening of that objective standard that is so essential to the independent progress of our study.

Education ranks with a group of studies that deal with humanity in its various aspects. Psychology naturally is the science that underlies them all, since it is the abstract study of human nature which is their raw material. But politics, economics, sociology, eugenics, all claim to be sciences, and if we probe into their standards we find that they are largely statistical. It is quite possible by careful investigation among the subject-matter of these sciences to organise a system of general principles based upon averages obtained from a very wide field of investigation. These principles are of very general application, though they may not enable us

to prophesy in individual cases. This, indeed, is at the root of a great deal of the criticism levelled at the claims of education to rank as a science. A parent or an education authority presents a boy to an educator and calls for a prophecy. The educator must decline, since he cannot honestly prophesy in an individual case, though he may be prepared to venture on a reasoned statement of what is likely to occur in the boy's educational career. The educator is, in fact, in precisely the same position as a medical man called in to a case. He can prophesy, but only in general terms. In both cases it is the application of general principles to a particular case.

This raises the whole question of the value of the average in matters of education. Psychologists, in addressing teachers, are beginning to warn them that the average is only an abstraction, and really does not exist. We are told that what the teacher has to concern himself with is "the living child here and now before him," and he is accordingly warned against the insubstantiality of the elusive abstract. But this is to confound two distinct things. It is true that the teacher must always deal with a living pupil here and now before him. But in his dealing with that living pupil he has to apply a paid-up capital of knowledge of men and of boys in general. He must seek to understand the living boy by the aid of knowledge previously acquired, and this knowledge is represented by the average. The master may be unable to prophesy with certainty how Jones minor will act under certain specified conditions. But from a knowledge of third form boys in general he can make a guess that is very likely to hit the mark. The teacher who applies his knowledge of the average third form boy to the minor Jones, without modification to suit Jones's case, acts unintelligently; but the possibility of blunders by a dull master does not reduce the value of the knowledge of the average in the hands of one who is capable. The concept of the average boy as it is developed by experience and study in the mind of the master forms a standard by which other boys may be estimated. This standard is partly subjective, partly objective. In so far as the standard is acquired by the personal experience of the master it is subjective. The unreasoned but very effective knowledge of boy nature that enables an efficient master who is guiltless of any acquaintance with educational theory to know how a boy is likely to act in given circumstances results from the training of experience, and is peculiar to its possessor. On the other hand, the knowledge of boy nature that has been acquired by deliberate study and by experiment is something that has an existence independent of the individual. It is objective, or at any rate has an objective bias.

We must distinguish in practice between the average and the type. The average boy may have no existence in reality, he may be a pure abstraction; but the type is concrete, and may be regarded as the embodiment of all the essentials that go to make up the average, with the addition of certain qualities that must be present in some form or other, though the particular form is immaterial. The average is to the type as the concept is to the generalised image. The type may form a very useful standard for masters whose tendency is strongly towards the concrete; but the average has a special and a different value, and in capable hands is more effectively applied because it is of a wider range. To consider a class as made up of types tends to break up the class feeling, and make the master think of his pupils as a mere group of separate individuals. Undoubtedly the master must in certain connections think of his pupils as individuals, but in other connections he must deal with his class as a whole, as a psychological unit.

This introduces one of the most striking developments of modern educational theory. The older psychologists treated their subject as limited to the study of the mature human individual. The introduction of the idea of development led to the founding of a genetic psychology with its consideration of the individual at his various stages. A further advance is marked by the appearance of collective psychology, which carries the study of the individual into his relations with other individuals. Naturally, both changes were of the greatest advantage to education. The first gave scientific guidance to the popular movement known as Child-Study, the second suggested the scientific study of the class as a collective organism. It is true that this collective psychology is at present in its infancy. But while we owe much to the French psychologists with their dazzling exposition, we are glad to turn to our more solid McDougall for the best scientific basis available for a sound collective psychology. The material he has supplied is waiting to be worked up from the educational side. His statement of the relation between the instincts and the emotions and his manipulation of Mr. Shand's theory of the sentiments provide tempting material for the establishment of an objective standard in connection with the training of the individual character and the interaction of individual characters in groups. Naturally, the results must be expressed in averages, and equally naturally there will be a complaint from certain practical educators. What is the use, it will be asked, of information about how classes in general act? What we want to know is how this particular class before which I stand is going to act. But this is to confound the practice of a science with the science itself. There must always be an intelligent intermediary between the principles of a science and their application to the affairs of life. In this respect the nascent science of education differs in no way from those that are more fully developed. The educator who prides himself on being specially practical is frequently very unreasonable in his demands from educational theory. He is rather apt to complain that it does not supply him with sufficiently detailed instructions. What he wants is a series of recipes which, if scrupulously followed, will inevitably produce certain specified results. But such men take a very humiliating view of their profession. So far from seeking this spoon-feeding, they should rejoice that their work demands the exercise of intelligent initiative. Herein consists, in fact, the dignity of the educator's office. He must be master of the organised knowledge that education has acquired, and must have the power of making the appropriate application of that knowledge to every case as it arises. To assist him in avoiding error he is entitled to look for an objective standard at the hands of those who make education their special study, but for the use of that standard he must himself accept the full responsibility.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE proceedings of the Geological Section at Dundee were of exceptional interest, and the attendances were large up to the end of the meeting. The success of the section was due to two or three special features. Many of the papers dealt with the problems of the Highlands and of the Highland border, questions which are full of knotty points, and the men who are engaged in solving these problems were able to assemble in the meeting-room and there

state their views and face discussion, which was often very lively and always full of vigorous earnestness. Then we had a commodious and quiet meeting-room, and the President (Dr. B. N. Peach) was a host in himself. As Dr. Heim said, in seconding a vote of thanks to him: "When I look in front I always see the sun," and the vivacious countenance and stirring enthusiasm of Dr. Peach were an incentive to all present to rise to their best.

After the delivery of the President's address on "The Relation between the Cambrian Faunas of Scotland and North America," which was a timely and most valuable deliverance giving the evidence for the land connection between North America and North-west Europe in Cambrian times, a lecture was delivered by Dr. T. J. Jehu on the local geology. After a brief reference to the exposures of the Highland Boundary series in Forfar and Kincardine, and to the recent discoveries of rocks of Downtonian age near Stonehaven, the lecturer dealt with the groups of rocks found in the area:—(1) The Highland metamorphic rocks; (2) the Old Red Standstone; (3) the Carboniferous system of Fife.

(1) The prominent series of metamorphic rocks comprises the Dunkeld slates, schistose slates and micaceous grits included in the Ben Ledi group. With the schists are associated the "Green Beds" of the Geological Survey and certain basic intrusions mapped as hornblende schists.

(2) Two divisions of the Old Red Sandstone are represented, Lower and Upper, separated by a marked unconformity. They consist of two sedimentary groups separated by the great volcanic series of the Sidlaws and the Ochils. The distribution and characteristics of the volcanic beds were described, and the probable positions of the vents from which the materials were ejected were indicated. The Lower Old Red Sandstone rocks were folded and denuded before the deposition of the Upper Beds, which pass conformably up into the Carboniferous System in Fife.

(3) The Carboniferous rocks of Fife consist of the Calciferous Sandstones at the base, overlaid by the Carboniferous Limestone series, which are overlaid by Millstone Grit and Coal Measures. Special attention was directed to the splendid development of workable coal-seams in the middle group of the Carboniferous Limestone series, as well as in the Lower Coal Measures of the district. The remarkable diversity of igneous rocks and the great development of volcanic rocks on the coast of Fife were described, and were subsequently displayed to the members by a field-excursion to Elie.

During the meeting various problems connected with the Pre-Cambrian rocks of the Highlands and the Highland border were thoroughly expounded and discussed.

Mr. E. B. Bailey described the occurrence in eastern Mull of a great breccia-formation with intercalated rhyolitic lavas. The breccia consists of an unbedded assemblage of blunted rocks and fragments of gneiss, granophyre, gabbro and basalt, often associated with rhyolitic *débris* of volcanic origin. The basalt lavas of Mull have been violently folded into a series of anticlines and synclines, and it is in one of these synclines that the main outcrop of the breccia is preserved. It appears that the breccia is a thick layer overlying the basalts and folded with them. Though some parts of the breccia may be of volcanic origin, Mr. Bailey suggests that the greater part has resulted from erosion, which operated during the period of upheaval of the ridges.

Dr. J. S. Flett opened a discussion on the sequence of volcanic rocks in Scotland in relation to the Atlantic-Pacific classification of Suess. He pointed out that the recognition of two great families of igneous rocks, the Atlantic and the Pacific, and their relation to certain types of earth-movement, which we owe to Mr. Harker, constituted one of the greatest advances in rational petrology. In Scotland the Carboniferous volcanic rocks are typical Atlantic types, associated with collapse and great faults, and the rocks of Lower Old Sandstone age are characteristic of the Pacific group (great crumbling). To the Atlantic group could be added the Permian or late-Carboniferous rocks of Ayrshire and East Fife, and the nepheline-basalts (presumably Tertiary) of Caithness with their associated camptonites and monchequites. The Tertiary volcanic rocks of the Hebrides and the abundant north-west dykes were also ascribed to movements of Atlantic type. The remaining rocks of Scotland Dr. Flett desired to assign to an independent, intermediate group. They are characterised by pillow-lavas and are not connected with movements either of the Pacific or the Atlantic kind, and may thus be placed in a special family.

Dr. Flett's address was followed by a vigorous discussion, in which considerable criticism was expressed of the terms Atlantic and Pacific, and especially of their application to types of rocks in Scotland; but Dr. Flett pointed out that some terms must be used, and these were convenient, but he was not pledged to them in any way. Dr. J. W. Evans (London) thought that Dr. Flett had made out a *primâ facie* case, so far as the Scotch volcanic rocks were concerned. He believed that the first differentiation of igneous rocks was a result of the separation of the original magma, on cooling, into two fluids, one consisting mainly of water, silica, alumina and alkalies, the other made up chiefly of magnesia and ferrous oxide with sufficient alumina and silica to form anorthite and the ferric minerals. Subsequent differentiation was principally due to crystallisation. In folded areas the segregation took place at a considerable depth, while the magma still retained its original aqueous contents. The primary differentiation was therefore comparatively complete, and the normal or "Pacific" series of rocks was ultimately formed. In districts of plateau faulting, on the other hand, the differentiation occurred nearer the surface and under conditions which facilitated the loss of water, so that the separation was imperfect, the basic portion retaining more silica and a considerable amount of alkalies, and subsequent segregation by crystallisation gave rise to the alkali or "Atlantic" series. He also suggested that the occurrence of sodium with the basic rocks might be due to the presence of an unusual amount of chlorine, which separated out with the basic constituents and brought the sodium with it.

Dr. Tempest Anderson did not agree with the suggestion that pillow-lavas had been formed in deep water, and gave instances which he had seen of their formation by lavas flowing into shallow waters, and apparently due to sudden cooling by the waves. Mr. G. W. Tyrrell (Glasgow) much preferred the terms "alkalic" and "calcic" for Dr. Flett's main divisions. The differences were mainly chemical and mineralogical, not geographical. Many group names cover a wide diversity of types, and we appreciate the great value of Dr. Flett's recognition of mono- and poly-phyletic rocks, that is, types highly characteristic of one group only and types to be found in all the main divisions of igneous rocks. Dr. Hatch pointed out the advantage of a division which recognises a well-defined suite of rocks in which the alkali and calc-alkali felspars are developed in equal proportions, a series to which Brögger has given the name Monzonite series, and hoped that such a classification would be generally adopted.

Mr. G. Barrow gave a valuable paper on the older granite in Lower Dee Side, in which he showed that in place of forming large coherent masses, it was

distinguished by *lit-par-lit* intrusions. The granite material in these cases formed minute sills parallel to the foliation of the associated gneiss into which it had been intruded. The granite rises as a dyke and the sills diminish in thickness and extent as they near the surface. In the interior parts the granite is usually grey and contains more biotite than muscovite, and oligoclase is usually abundant. The oligoclase and biotite are found to diminish steadily as the rock is traced towards the taper end of the sills. At this point there is little oligoclase and often no biotite; muscovite is fairly common and the bulk of the felspar is of alkaline composition. It would appear that the fissures in which the dykes occur were filled with igneous material, and that under great pressure the walls were burst open and the still liquid material forced out, and thus separated from that which had already become segregated. This phenomenon may be described as magmatic differentiation intensified by dynamic action. Mr. Barrow also read a paper on buckled folding. Descriptions have been published of areas of regional crystalline metamorphism in which the dip of the bedding is described as at a low angle over a considerable area. Experience is gradually proving that these altered sediments are always intensely folded, and the low dips really represent the most complicated structure, for which the name "Buckled Folding" is suggested. This structure is best seen in the Moine Gneisses, and its development can be studied in the cliff sections between Stonehaven and Muchalls. The grits and shales on the limb of the folds, near Stonehaven, ascend the cliffs in an unbroken course from bottom to top, being isoclinal and unbent. But as we proceed northwards the course of the grit bands up the cliff face is no longer straight, but a small overfold, or "buckle," is developed in it. At first only one is seen in the whole height of the cliff, then two, then three, and so on, until they are so close together that the still straight portion of the fold is no longer than the "buckled" or overfolded portion. If the upward course of each grit band be followed, it will be found that this structure does not alter the dip of the band as a whole. It still descends at much the same angle, but by a zigzag course. The overfolds all face in the same direction right up to Muchalls, and must have been produced after the isoclinal folding was completed. There is no justification for separating the buckled beds from those in which buckling does not occur. A key to the connection is found in the area about Shiehallion, where the quartzose beds forming the margin of the quartzite and containing the boulder bed and the limestone show isoclinal folding; whereas further north the same group comes on again, but this time with buckled folding, or Moine gneiss.

Dr. B. N. Peach and Dr. J. Horne described some interesting investigations which they had recently made on the Archæan rocks of Lewis, in which they showed how closely these beds corresponded to the rocks of the adjoining mainland, without the great series of acid intrusions. The structure is coarsely granulitic, and there is a marked absence of the pyroxene-gneisses with blue quartz, of pyroxene-granulites, and other basic forms, which are so characteristic of the mainland. The remarkable series of basic dykes in the west of Sutherland had not been detected in Lewis. The north-west and south-east strike, referred to by Murchison, was not characteristic of the gneisses of Lewis. The dominant strike is almost north and south, but north-east to south-west or east to west in other areas. The flaggy granulitic gneisses of the Butt of Lewis, which appear to run southwards along the belt of high ground between Stornoway and Barvas, resemble closely the Moine gneisses east of the Moine thrust-plane, but they differ petrologically from the rocks of sedimentary origin which form the Moine series. The system of overfolding and the direction of the axial planes of the folds approximate to those found in the Moine rocks on the mainland. The platy rocks, or mylonites, occur along definite lines of movement approximately north to south, and thrust-planes have been detected which point to displacement in a westerly direction. Various stages in the development of mylonites from the acid and basic gneisses are represented. In the discussion which followed the value of these investigations was emphasised by Dr. Flett and others.

Important discoveries of fossils in old rocks were announced by Dr. R. Campbell (Edinburgh) and Prof. T. J. Jehu (St. Andrew's). Dr. Campbell described fossil remains found in the Jasper and Green Schist series of the Highland border, at Craigeven Bay, Stonehaven. Crushed spilitic lavas with intercalated black shales, jaspers, and cherts, which in their lithological characters resemble closely the green igneous rocks and associated sediments along the line of the Highland fault, appear on the old Geological Survey maps as of (?) Arenig age. In 1909, in company with Dr. Peach and Dr. W. T. Gordon, the author found several fossils in the black shales. Detailed search by Mr. D. Tait revealed fossils of the forms Lingulella, Obolella, Acrotreta, Linnarssonia, and Siphonotreta; a bivalve phyllocarid allied to Caryocaris and Lingulocaris; and cases of a tubuloid worm. The above genera are most commonly found in the Ordovician beds and in the Upper Cambrian, but, owing to the absence of graptolites, Dr. Peach suggested that Upper Cambrian was the most probable age. Whatever may be the ultimate decision as to their stratigraphical horizon, the discovery of these fossils leaves very little doubt that the boundary fault series is *not* pre-Cambrian.

Dr. Jehu followed this paper by one on the discovery of fossils in the boundary-fault series, near Aberfoyle. This series is well exposed between Loch Lomond and Callendar, forming a narrow belt separated by a reversed fault from the Lower Old Red Sandstone on the south-east, and probably by a line of thrust from the Leny Grits on the north-west. It consists of black and grey shales, cherts, grits, and calcareous beds. Remains of Radiolaria were discovered by Dr. Peach some years ago in cherts near Gualann. Recently a number of fossils have been found in pale-grey chert bands near Arndrum. These fossils occur in muddy films in the chert belt. They are almost all hingeless brachiopods, and the following forms have been determined by Dr. Peach:—Acrotreta, Lingulella, Obolus, Obolella; also the flattened chætæ of polychæte worms. These fossils were regarded as indicating an Upper Cambrian age. Dr. Horne, in the discussion, regarded the collection of fossils from the chert and green-schist series at Stonehaven and Aberfoyle as the most important palæontological "find" affecting Highland geology since the discovery of Olenellus in the west of Ross-shire. The strata containing these fossils, which had been provisionally referred to the Upper Cambrian by Dr. Peach and Dr. Walcott, could no longer be considered as of pre-Cambrian age, like those of similar rocks in Anglesey. At a subsequent meeting Dr. Horne read a letter from Dr. Ami (Toronto), who had examined Dr. Jehu's collection of fossils from Aberfoyle, and found them closely resembling those obtained from Upper Cambrian beds belonging to the Quebec group. His opinion was based partly on the brachiopods and partly on the occurrence of an obscurely preserved graptolite resembling *Retiolites ensiformis*, Hall—a type eminently characteristic of the Sillery Sandstones of the Quebec group of Upper Cambrian age. Dr. Horne further stated that this form had been shown

to Miss Ellis (Cambridge), who recognised it as a graptolite with Ordovician affinities.

Dr. A. W. Gibb (Aberdeen) read a paper on an actinolite-bearing rock allied to serpentine associated with the basic intrusion of Belhelvie. Towards the northern end of this mass, which consists of troctolites, serpentines, and allied types, there is a rock which shows a large number of dark-green rounded spots, set in a fine felt of paler green colour, full of glancing needles. Under the microscope the spots are seen to represent olivine, partly unaltered, partly serpentinised, as well as granulitised and drawn out. The rest of the rock is largely made up of actinolite in small crystal flakes, and green spinel and abundant magnetite are present. The exposure has recently been blasted away.

Dr. Wm. Mackie described the volcanic rocks round the Ord Hill of Rhynie, Aberdeenshire. The group embraces at least three lava flows, with associated tuffs and interbedded and overlying sedimentary rocks. Flow brecciation is frequent, and the tuffs are rhyolitic. The sedimentary rocks of the group consist of hard siliceous grits, which, under the microscope, show volcanic fragments. The whole of the group is characterised by fine, secondary quartz infiltration veins. They overlie the basic rocks of the younger Grampian granite series, but are probably considerably older than the oldest Old Red beds of the adjoining area. The lavas, being of an acid type, cannot be correlated with the interbedded andesites of the Old Red Sandstone.

Mr. G. W. Tyrrell (Glasgow) described the alkaline igneous rocks of Ayrshire. Recent work of the Scottish petrologists shows that one of the greatest developments of rocks characterised by primary analcite is contained in the midland valley of Scotland, one centre being in Ayrshire, the other in the area surrounding the Firth of Forth. Geologically these analcite rocks are Carboniferous in age, having a time-range from Carboniferous Limestone to Early Permian. They occur in the form of stratiform sills, lenticular intrusive masses, volcanic plugs, and as a series of lava flows. No masses of true plutonic habit are known.

Passing to Wales, a paper was read by Mr. Edward Greenly on the origin of some of the mica-schists of Anglesey. The mica-schists of southern and central Anglesey are holocrystalline rocks with strong parallel structure, and composed essentially of quartz, alkali-felspars, and white mica. Dr. Teall regards them as broken-down and partially reconstructed porphyritic felsites. Twenty-five years ago Dr. Callaway recognised their felsitic origin, which the present investigations confirm. These schists, therefore, may be looked upon in general as derived from acid igneous rocks. In some areas mica schists in continuity with them are found in intimate relations to schists of sedimentary origin, so that, probably, pyroclastic material was present in the original igneous series.

Dr. Robert Campbell (Edinburgh) gave a valuable *résumé* of his recent investigations on the Lower Old Red beds of Kincardineshire, showing that a thickness of 3000 ft. ought now to be transferred to the Downtonian, the uppermost group of the Silurian system. At the base of the series near Stonehaven there is 200 ft. of breccias interbedded with fine red mudstones made up mainly of fragments of the underlying (?) Upper Cambrian rocks, and resting unconformably on them. Near Cowie Harbour there occurs a thick belt of grey and greenish mudstones which yield Dictyocaris in abundance. Ceratiocaris, Archidesmus, Eurypterus, and other forms have been obtained from the same horizon, and in another bed numerous plates of a new Cyathaspis have been found. These interesting fossil finds, which in other areas do not occur in rocks younger than the Upper Silurian, and the lithological characters recall the typical Downtonian of the south of Scotland. These beds pass upwards into the micaceous sandstone and conglomerates of Stonehaven Harbour, which may be considered as the base of the Lower Old Red Sandstone. The fish remains were examined by Dr. R. H. Traquair, who reported that the small scutes were referable to the category of Cephalaspidian scutes, that the species to which they belong is pretty certain, but additional material is required before proceeding further with identification. He described several specimens of a beautiful new Cyathaspis, which he dedicated to Dr. Campbell.

Mr. C. J. Gardiner gave an account of the Silurian inlier of Usk. It is an oval area, eight miles by four, crossed by an important east and west fault. The southern half is composed of two anticlines separated by a fault. The axes of these folds run north and south, and dip southwards. The western anticline is the larger of the two, and shows Wenlock Shales and Limestone and Ludlow beds. The northern half of the inlier is far less simple than the southern in its structure, and is more concealed by drift. The Wenlock Limestone is not met with in this half. The simplest explanation is that the Wenlock Shale is faulted against the Ludlow beds on both sides. As the Aymestry Limestone is absent from the area, it is impossible to separate the Ludlow beds into an upper and lower division. The main boundary faults are crossed at several spots by minor east and west faults which cause small lateral displacements.

There were three important contributions from the palæobotanical side. Dr. Marie C. Stopes gave an outline of a controversy in New Brunswick between the palæobotanists and the stratigraphers. In the "Fern Ledges" of St. John there is a rich fossil flora, but no animal remains. Sir W. Dawson described the plants as Devonian. Recent attempts have been made to include the beds in the Silurian for stratigraphic reasons. The author's work in the field indicated considerable overthrust. The unique series had recently been redetermined. Type specimens had been lent by the Canadian museums and brought to London and Paris for comparison, resulting in the identification of a large proportion of well-known European types in the "Fern Ledges" flora as Carboniferous and mostly typical of the Westphalian division of the Coal Measures.

Dr. W. T. Gordon read a paper on the fossil flora of the Pettycur Limestone in relation to botanical evolution. The flora of the Pettycur Limestone (Lower Carboniferous) has a double interest. These forms constitute fragments of the oldest known flora, as Lower Carboniferous plants do not differ markedly from the Upper Devonian forms. Although the Devonian flora is distinct from that of the Permo-Carboniferous epoch, yet the organisation does not indicate that the plants were primitive. The result of Dr. Gordon's investigations was that the flora represented in the Pettycur Limestone appears, on the whole, to contain more generalised and simpler types than occur in the Coal Measures and later strata, and these types may be arranged in order so as to suggest certain possible lines of evolution.

Mr. W. R. Don (Dundee) read a paper on the nature of *Parka decipiens*. This fossil is the only common and quite the most characteristic fossil of the Lower Old Red Sandstone of the Kincardine-Forfar-Perth area. A re-investigation, chiefly microscopical, has been attempted with the aid of Schultz's solution (strong nitric acid and potassium chlorate). Most previous investigators had pronounced it to be vegetable, though Mantell, Lyell, and others considered it as an

egg-packet of Pterygotus. The conclusions of the author were confirmatory of those of Sir W. Dawson and Prof. Penhallow that it was vegetable, and after boiling in nitric acid, the presence of spores within the carbonised tissue was demonstrated. In attempting to form some conception of the original structure and shape of Parka, the author concluded that the original spore-containing tissue was almost flat, not spherical, and unlike any known sporangia of to-day. There was, certainly, intimately connected with it a so-called "indusium." In the discussion, Dr. G. Hickling stated that his independent observations on Parka were in very close agreement with those of Mr. Don. He questioned, however, the nature of the cells, hitherto regarded as spores, and preferred to consider them as constituting simply a parenchymatous mass. These masses possibly served as reproductive buds analogous to the gemmæ of the Hepaticæ. Dr. Newell Arber (Cambridge) remarked on the extreme interest of Mr. Don's careful work on Parka, and was quite prepared to allow that the organs termed spores were undoubtedly of that nature. He differed from Dr. Hickling's criticisms, and pointed out that if these bodies were not spores, but parenchymatous cells, they certainly could not have survived the extremely severe chemical treatment to which they had been subjected. Dr. Hickling appeared to have examined chiefly spore sacs in which the spores were not yet mature, a condition also commonly noticed in some of Mr. Don's specimens, and this appeared to have been the chief basis of his criticism. Dr. Arber agreed with Mr. Don that Parka was undoubtedly a member of the Thallophytæ, and very possibly an alga.

The first results of investigations on the contents of the Millstone Grit of Yorkshire were communicated by Mr. Albert Gilligan (Leeds). Following up the work of Dr. Sorby, the late Mr. A. Longbottom had collected some very large pebbles from the Middle Grits of Silsden. These had been examined by the author, who had extended his researches to other beds of the series in Yorkshire. Some of the pebbles were of considerable size and showed a remarkable assemblage of rocks. By far the most common were acid igneous rocks. Only one specimen of a basic igneous rock had been found. The metamorphic rocks were quartz-schist and mica-schist, with a few fragments of gneiss. Numerous pebbles were found to be perfectly fresh microcline. Pieces of pegmatite were common. Some fragments obtained from the Plompton Grit proved to be a peculiar silicified oolitic rock. A few pebbles showed traces of organisms such as sponge spicules. The heavy minerals of the grits were not numerous, zircon and garnet being the most plentiful. The felspars in the grit were quite fresh, and this suggests either disintegration of the parent rock by differences of temperature and rapid transportation, or comparative absence of carbonic dioxide in the atmosphere. The author had been much impressed by the many points of similarity between the Millstone Grit and the Torridon Sandstone, and was disposed to think that areas of similar rock types were laid under contribution for each.

Mr. T. O. Bosworth gave an account of some investigations into the heavy mineral grains in the sands of the Scottish Carboniferous. The chief heavy minerals found were garnet, zircon, magnetite, tourmaline, rutile, staurolite, anatase, barytes. The sands containing an extraordinary amount of angular garnet were probably derived from the Highland schists of the north and north-west. The sands devoid of garnet probably came from the north-east, east, or south.

Mr. J. S. Owens communicated the results of some experiments on the settlement and transport of sand in water. It was shown that there is a definite relation between the rate of settlement and the temperature of the water. The curves show that velocity of fall varies almost with the water temperature, the rate being always increased by rise of temperature, but that as the diameter of the grains increases the temperature effect becomes less, until for grains more than one-tenth inch in diameter the effect is practically negligible.

Mr. Edward Greenly contributed a theory of the Menai Strait, in which he accepted Ramsay's view of the Strait as a glacial furrow, but the middle of the Strait cannot be explained in that way. Evidence was adduced to show that this reach was excavated by glacial waters during the recession of the ice at a time when the mutual relations of the ice of the mountain land and of the sea-basin admitted of the accumulation of a temporary lake. Post-glacial erosion and subsequent changes of level have completed the bed of the Strait as it now exists.

The origin of kopjes and inselberge was dealt with by Dr. J. D. Falconer. It had been suggested that a landscape with inselberge was of desert origin, but the various phenomena could be explained more readily as the result of weathering and erosion during successive small oscillatory movements of a regional character in the neighbourhood of base-level.

Mr. G. W. Grabham gave notes of an exploration of the country north of Lake Albert. This area extends west from Rejaf to the watershed and southwards as far as the lake. It is entirely composed of gneisses, which are for the most part affected by a north-south foliation. The only member of apparently sedimentary origin consists of a band of quartzite which is traceable for some distance. Among the gneisses, a group characterised by graphitic pegmatite was recognised. Some intrusions occur among these gneisses, and form the only intervening link in time between them and the surface deposits. In the country north of Lake Albert extensive deposits belonging to an extinct lake were found. Lake Ismail, as it is proposed to call this lake, stood about 600 ft. above the present river-level, and its site is marked by gravels and beds of clay. Its limits are uncertain, but it did not extend into the area now occupied by Lake Albert. In later times the crust fractures of the Rift Valley occurred, and the present lake and river system was initiated. In more recent times still the river has again been modified by crustal movements.

The usual grants were recommended for the continuance of committees of research, and a new committee was formed to investigate the fish beds of Dura Glen. The meeting was attended by a large number of foreign geologists, who took an active interest in the discussions of the section. Among them were Prof. C. Barrois (Lille), Dr. Tschernyschew (St. Petersburg), Prof. A. Heim (Zurich), Dr. H. Reusch (Christiania), Prof. J. Welsh (Poitiers), Prof. E. Trietze (Vienna), Dr. Pirrson (Yale), Dr. Leith (Wisconsin), Dr. Ami (Toronto). The annual geological dinner was held at the Royal Hotel on Friday evening (September 6). Dr. Peach made a most genial chairman, and delighted the audience by rendering the "Song of the Seraphim," specially written for the Red Lion Club dinner held during the Dundee meeting in 1867, and then sung by the author, Dr. Henry Woodward, to the tune of "Bonnie Dundee." The menu card was graced by a photographic copy of the picture of Sir Charles Lyell painted in 1870 by Lowes Dickenson, when Sir Charles was seventy-three years of age. The picture was on view in the loan collection. Dr. Jehu and his assistants arranged three enjoyable excursions for the afternoons, and a whole day to see the wonderful coast sections of Carboniferous puy eruptions near Elie. At the close of the meeting two extended field excursions were arranged, one

to Loch Assynt, under the leadership of Dr. Peach and Dr. Horne, and another to the country between Aberdeen and Arbroath, under the leadership of Mr. Barrow, Dr. Campbell, and Dr. Hickling. These were very enjoyable and instructive, and proved great attractions to the foreign geologists and a large number of their British *confrères*.

W. LOWER CARTER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The John Winbolt prize has been awarded to R. V. Southwell, of Trinity College, for an essay on "The Failure of Thin Tubes by Instability or Secondary Flexure."

BIRMINGHAM.—During the winter and spring terms two courses of lectures on "Civic Design and Town Planning" are to be given, by Mr. Raymond Unwin, in the department of civil engineering.

The following appointments have been made:—Mr. C. Walker as lecturer in physiology; Mr. Laurence Ball as assistant lecturer in pathology and bacteriology; Mr. P. M. Chadwick, assistant lecturer and demonstrator in civil engineering; Mr. A. Clubb, demonstrator in mining (as successor to Mr. C. D. Mottram); Mr. H. I. Coe, assistant lecturer and demonstrator in metallurgy. Mr. Percy May has resigned his post as assistant lecturer and demonstrator in chemistry, and Mr. Frederick Challenger has been nominated to the vacancy.

A COURSE of free lectures to teachers on "The Past Around Us," a series of brief studies introductory to the folk-culture of Britain, is being given by Mr. Walter W. Skeat, at the Horniman Museum, Forest Hill, S.E., on Saturday mornings, from October 12 to December 14. Admission is by ticket only, to be obtained from the Clerk of the London County Council.

LECTURES on volcanic action, earth movements, the geological action of water, and the evolution of scenery and life on the globe are to be delivered by Dr. Werner Marchand on October 17, 24, and 31, in the meeting rooms of the British Esperanto Association, 133 High Holborn (Museum Station Buildings), W.C. They will commence at 7.30 p.m., and will be delivered in Esperanto.

THE winter meetings of the Child Study Society begin this evening at the Royal Sanitary Institute, when Dr. T. P. Nunn will lecture on the psychological development of the school subjects. The list of lectures and discussions to be held this year provides many subjects of interest to students and teachers concerned with the education of children. Particulars as to membership may be obtained from the honorary secretary of the society, Mr. W. J. Durrie Mulford, 90 Buckingham Palace Road, London, S.W.

THE University College (London) Committee will shortly proceed to fill the vacancy in the Quain studentship in biology which has been created by the resignation of Mr. E. J. Salisbury, on his appointment as lecturer in botany at the East London College. Any student of the college is eligible for the studentship who has for at least three terms attended one or more classes in the special study in respect of which the studentship is awarded. Applications should be received on or before Saturday, October 26.

FOR some time articles have been appearing at regular intervals in the Journal of the Department of Agriculture and Technical Instruction for Ireland describing recently established Irish technical schools. These articles have been published afterwards as separate pamphlets for distribution by the department. The twelfth and thirteenth contributions to the series have been received in booklet form. The former is called "Technical Instruction in Limerick," and has been written by Mr. J. Comerton, the principal of the Limerick Technical Institute; the other deals similarly with Cork, and is by Dr. John H. Grindley, principal of the Crawford Municipal Technical Institute, Cork. The accounts of the work done in technical education in these important Irish industrial centres provide excellent evidence of the success which is attending the department's efforts to meet the educational needs in different parts of Ireland.

THE distinguishing characteristic of the calendar for the present session of the City of Bradford Technical College is the excellent series of thirty plates, which chiefly illustrate the very complete arrangements made for the practical study of the branches of technology on which the industries of the district depend. This college awards certificates, diplomas, and an associateship. The diploma of the college is awarded to each day student who has been in attendance for three complete sessions, subsequent to passing an entrance examination, and has passed the college examinations in all subjects of the diploma course taken. The diploma is awarded to evening students under the same regulations as to day students, except that an evening student who has been at least three years in attendance, and has obtained the ordinary certificate, is exempt from the first-year diploma course. To become an associate a candidate must be twenty-one years of age and have had at least one year's practical experience with a firm engaged in his trade or profession, subsequent to obtaining the diploma. Some of the subjects in which diplomas may be obtained are: preparing, combing and spinning, weaving and cloth structure, chemistry and dyeing, and power production and transmission.

ON Wednesday, October 9, at Bradfield College, Berks, a new block of science rooms was opened by Sir William Osler, F.R.S. A large proportion of the boys at the college have studied science during the last twenty years, and some fifty to seventy pupils work in the mechanical shops added in 1898. The new science schools have this year been added to deal more effectively with the growing demand, and mainly through the efforts of the present headmaster, the Rev. H. Costley White. Among the assembly present at the ceremony were the warden (Mr. Edward Armstrong), the Right Hon. G. W. Palmer, Mr. R. Dyke Acland, K.C., Sir Arthur Rücker, F.R.S., and Mr. J. H. Benyon. Sir William Osler, in a speech after the ceremony, dwelt on what he considered to be an ideal education for those suited to and seeking scientific pursuits in after life. He would have a thorough knowledge of Latin and Greek; he believed in the optimistic Greek outlook on life for boys; during his last two years the boy should specialise in science, which should occupy most of his school hours. The speaker objected very strongly to the use of the term "stinks" as applied to science study. He said that that one word had done more harm in implying discredit to, and in keeping back pupils from the study of, the subject than any other factor. The new science block is detached from the rest of the school buildings, and has an attractive exterior. The entrance lobby leads into two chemical laboratories on the right and two physics rooms on the left, each easily accommodating twenty boys. In the chemical laboratories each room is adequately fitted with fume cupboards, balance slabs, and store cupboards, and has a raised demonstration bench at one end of the room. The two physics rooms are each sup-

plied with three central tables and side benches round the walls, balance slabs, and large sinks. Behind the entrance lobby is a lecture-room with raised tiers to accommodate fifty boys, with a demonstration bench, fume cupboard, and lantern screen. The architects are Messrs. Steward Smith and Hutt, of Reading, the builders Messrs. Hughes, of Wokingham, and the furniture has been supplied by Messrs. Baird and Tatlock.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 7.—M. Lippmann in the chair.—Maurice **Hamy**: An arrangement of the arc with iron electrodes working with alternating currents. The spark spectrum of iron, used as a comparison spectrum, presents difficulties owing to the variations caused by slight changes in the experimental conditions. The arrangement of the arc between iron electrodes described in the present paper was designed to replace the spark as a source of the iron spectrum.—Gustave **Sannia**: The simple characteristics of partial differential equations with two variables.—N. **Saltykow**: The theory of partial equations.—U. **Cisotti**: The movement of a solid in viscous liquid.—E. **Mérigeault**: The influence of the velocity of combustion on the efficiency of a gas motor.—V. **Auger**: A new volumetric method for the estimation of uranium. The solution is reduced with metallic zinc and titrated with a standard solution of a ferric salt, using ammonium thiocyanate as indicator.—Paul **Gaubert**: The polychroism of crystals of potassium sulphate artificially coloured.—Marcel **Mirande**: The presence of hydrocyanic acid in *Trifolium repens*. The presence of hydrocyanic acid, or of a substance giving rise to it under the action of an enzyme, was proved in the stems and leaves of this plant. None was found in the roots.—C. **Dhéré** and W. de **Rogowski**: The absorption of the ultra-violet rays by α- and β-chlorophyll and by crystallised chlorophyll. Pure chlorophylls are remarkably transparent for the ultra-violet rays.—Léopold Le **Moult**: The destruction of certain Hemiptera by vegetable parasites.—M. and Mme. Pierre **Delanoë**: The relations between the cysts of Carini of the lung of the rat and *Trypanosoma lewisi*. The authors conclude that the pneumocysts of Carini represent a new parasite of the rat; they are not connected with *Trypanosoma lewisi*.—E. **Foëx**: The "Fibrinkörper" of Zopf, and their relations with the metachromatic corpuscles.

NEW SOUTH WALES.

Linnean Society, August 28.—Mr. W. W. Froggatt, president, in the chair.—G. I. **Playfair**: The plankton of the Sydney water-supply. The Sydney water-supply is the water of the Nepean and Cataract Rivers, which is impounded in the Cataract Reservoir, and thence brought down, by many miles of canal, through the Prospect Reservoir to Guildford and Pott's Hill, where it is filtered by being passed through a double series of wire screens. These screens being periodically raised and washed with a hose, the effluent from this operation has been the principal source of the material studied.—Allan R. **McCulloch**: Descriptions and figures of three young specimens of sunfish (Molacanthus) from the Central Pacific Ocean. The specimens described were received by the trustees of the Australian Museum from Dr. Thomas D. Liddle, R.N. They are only 9·5-13 mm. long, and were taken from the stomach of a kingfish caught swimming near the surface during the passage of H.M.S. *Torch* between the Ellice and Union Islands, Central Pacific, in 1911.—H. J. **Carter**: Notes on Stigmodera, with descriptions of new species and of other Buprestidæ. Eleven species of Stigmodera are proposed as new, comprising five from West Australia, four from Queensland, one from New South Wales, and one from Victoria. Two species of Neocuris and one of Curis, all from Queensland, are also described.

CALCUTTA.

Asiatic Society of Bengal, September 4.—L. L. **Fermor**: Preliminary note on the origin of meteorites. As the result of investigations into the conditions of formation of garnets, especially with respect to pressure, the author has been led to postulate the existence, below the plutonic rocks of the earth's crust, of a zone of rocks characterised by the abundant presence of *garnets*, the garnets being the result of the high pressures (and temperatures) existing in this zone. For this zone the author proposes the term *infraplutonic*. Armed with the conclusions thus obtained with reference to terrestrial rocks, the author proceeds to the consideration of meteorites, in particular of the stony forms known as aerolites; he is able to offer an explanation of the round bodies known as *chondrules*, so characteristic of many stony meteorites; he shows that each chondrule was once a garnet, and that the rock now represented by the chondritic meteorite must have been a garnetiferous eclogite situated at a considerable depth below the surface of some primeval stellar body. The disruption of this body was accompanied by a sudden reduction in pressure, which caused the garnets to liquefy with increase of volume. The rapidly decreasing temperature after this disruption caused the rapid crystallisation of these liquid drops with formation of the radiate and other crystalline aggregates of enstatite and olivine (sometimes with glass) so characteristic of chondrules. Starting from this interpretation of the chondritic meteorites the author is able to refer each of the great groups of meteorites to their respective positions in the primitive stellar body before disruption.—Anukul Chandra **Sircar**: A possible chemical method of distinguishing between seasoned and unseasoned teak wood. The work of R. Romanis on "Certain Products from Teak" has been extended with a view to determine whether the composition of the resinous extracts might be used as a criterion for the extent of seasoning of teak wood. The results obtained by this method were not encouraging, but another is indicated wherein the percentage of a white, crystalline body obtained from the wood by steam distillation is used as an index of the amount of seasoning.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts 5 and 6 for 1912, contain the following memoirs communicated to the society:—

October 28, 1911.—F. **Klein** and M. **Brendel**: Materials for a scientific biography of Gauss. ii., Fragments on the theory of the arithmetico-geometric mean from the years 1797–99, explained by L. Schlesinger.

December 23, 1911.—Th. von **Kármán**: The mechanism of the resistance experienced by a body moving in a fluid.

January 13, 1912.—L. E. J. **Brouwer**: The topological difficulties in proving the continuity of the existence-theorem for one-valued reversible polymorphous functions on Riemann's surfaces.

February 18.—L. **Geiger** and B. **Gutenberg**: Seismic waves. vi., Constitution of the interior of the earth, derived from the intensity of longitudinal and transversal seismic waves, with some observations on prodromals.

March 2.—G. **Tammann**: The dependence of crystalline form upon temperature, and on re-crystallisation in conglomerates.—L. **Bieberbach**: $\Delta u = e^u$ and the automorphous functions.

BOOKS RECEIVED.

Memoirs of the Geological Survey, Scotland. The Geology of the Districts of Braemar, Ballater, and Glen Clova. By G. Barrow and E. H. C. Craig, with contributions by L. W. Hinxman. Pp. vi+138. (London: H.M. Stationery Office.) 2s. 6d.

Transport de Force. By C. Le Roy. Première Partie. Pp. ii+172. (Paris: A Hermann et Fils.) 6 francs.

The Elements of Qualitative Chemical Analysis. By Prof. J. Stieglitz. Vol. i., parts 1 and 2. Pp. xi+312. Vol. ii., parts 3 and 4. Pp. viii+151. (New York: The Century Co.) 1.40 dollars and 1.20 dollars.

Michael Heilprin and His Sons: a Biography. By G. Pollak. Pp. xvi+540. (New York: Dodd, Mead and Co.) 3.50 dollars net.

Telephotography. By C. F. Lan-Davis. Pp. xi+130. (London: G. Routledge and Sons, Ltd.) 2s. net.

The Sociological Value of Christianity. By Dr. G. Chatterton-Hill. Pp. xxii+285. (London: A. and C. Black.) 7s. 6d. net.

The Cotton Plant in Egypt. By W. L. Balls. Pp. xvi+202. (London: Macmillan and Co., Ltd.) 5s. net.

Studies in Light Production. By Dr. R. A. Houstoun. Pp. iv+115. (London: *The Electrician* Printing and Publishing Co., Ltd.) 5s. net.

Electromagnetic Theory. By O. Heaviside. Vol. iii. Pp. ix+519. (London: *The Electrician* Printing and Publishing Co., Ltd.) 21s. net.

Memoirs of the Geological Survey, England and Wales. The Water Supply of Surrey, from Underground Sources, with Records of Sinkings and Borings. By W. Whitaker, with contributions on the Rainfall by Dr. H. R. Mill. Pp. v+352+map. (London: H.M. Stationery Office.) 7s.

The Physics and Chemistry of Mining. By T. H. Byrom. Pp. xii+196. (London: Crosby Lockwood and Son.) 3s. 6d. net.

The Sheep and its Cousins. By R. Lydekker. Pp. xv+315. (London: G. Allen and Co., Ltd.) 10s. 6d. net.

Jahrbuch der drahtlosen Telegraphie und Telephonie. By Prof. J. Zenneck. Edited by Dr. G. Eichhorn. Band v., Heft 1-6. Pp. 650+vi. (Leipzig: J. A. Barth.)

Elementary Chemical Theory and Calculations. By Dr. J. Knox. Pp. vii+103. (London: Gurney and Jackson.) 2s. net.

Physiologische Morphologie. By Prof. S. Passarge. Pp. 205. (Hamburg: L. Friederichsen and Co.)

Perfect Health for Women and Children. By E. S. Chesser. Pp. xi+276. (London: Methuen and Co., Ltd.) 3s. 6d. net.

The Mechanistic Conception of Life. By Dr. J. Loeb. Pp. vi+232. (Chicago: The University of Chicago Press; Cambridge: The University Press.) 6s. net.

Katalog der paläarktischen Hemipteren. By B. Oshanin. Pp. xvi+187. (Berlin: R. Friedländer und Sohn.) 12 marks.

Conférences sur Quelques Thèmes Choisis de la Chimie Physique Pure et Appliquée. Faites à l'Université de Paris du 6 et 13 Mars, 1911. By S. Arrhénius. Pp. ii+113. (Paris: A. Hermann et Fils.) 3 francs.

Life: its Nature, Origin, and Maintenance. By Prof. E. A. Schäfer. Pp. 36. (London: Longmans and Co.) 1s. net.

The Growth of Groups in the Animal Kingdom. By Dr. R. E. Lloyd. Pp. vii+185. (London: Longmans and Co.) 5s. net.

The Snakes of South Africa: their Venom and the Treatment of Snake Bite. By F. W. Fitzsimons. New edition. Pp. xvi+547. (Cape Town and Pretoria: T. M. Miller; London: Longmans and Co.) 12s. 6d. net.

A Text-book of Physics. By H. E. Hurst and R. T. Lattey. 3 vols. Pp. vi+205; 177; 258. (London: Constable and Co., Ltd.) 3s. 6d. net; 3s. 6d. net; 4s. net.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 17.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Flotation Process: as applied to the Concentration of Copper Ore at the Kyloe Copper Mine, New South Wales: J. W. Ashcroft.—Notes on the Collection of Precious Metals as Speiss in the Smelting of Antimonial Concentrates: G. C. McMurtry.—A System of Sand-filling used on the Rand: R. E. Sawyer.

FRIDAY, OCTOBER 25.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Characteristic Dynamical Diagrams for the Motion of a Train during the Accelerating and Retarding Periods: Prof. W. E. Dalby.

PHYSICAL SOCIETY, at 5.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.